DOCUMENT RESUME

ED 286 724 SE 048 562

TITLE Trends in the Chemical Industry. 1987 Survey of ACS Corporation Associates.
PUB DATE 3 Jun 87
NOTE 90p.
AVAILABLE FROM American Chemical Society, 1155 Sixteenth St., NW, Washington, DC 20036 (first copy free as long as supply lasts).
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Chemical Industry; *Chemistry; *College Science; *Engineering Education; Higher Education; Information Needs; Interdisciplinary Approach; International Cooperation; *National Surveys; *Professional Associations; Public Opinion; Science and Society; Science Education; Technological Advancement; Telecommunications
IDENTIFIERS *American Chemical Society

ABSTRACT

In July, 1986, the American Chemical Society (ACS) initiated a study which was intended to address future trends in the chemical industry. A survey was developed by and distributed to the member companies of Corporation Associates, which is the formal link between ACS and the chemical industry. The Executive Summary of the report, which makes up the first section of the document, identifies and discusses the following findings: (1) a significant majority of company representatives are generally satisfied with the quality of recent graduates in the chemical sciences and engineering; (2) the chemical industry is being intermingled with other disciplines in the pursuit of new endeavors, such as biotechnology; (3) information requirements have increased and there is more demand for information to be available electronically; (4) only modest changes in the availability of human resources were observed; (5) public image of the chemical industry has deteriorated; (6) international science and technology communications are on the rise; and (7) the image of the ACS has remained that of a competent, professional organization. Section two, which makes up the major portion of the document, contains a compilation of the responses to the questions included in the survey. Some references for further reading comprise section three. (TW)

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# 1987 SURVEY OF ACS CORPORATION ASSOCIATES

## "TRENDS IN THE CHEMICAL INDUSTRY"

**Presented to ACS Executive Director John K Crum on June 3, 1987**

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## OVERVIEW

## CORPORATION ASSOCIATES SURVEY

## "TRENDS IN THE CHEMICAL INDUSTRY"

On July 19, 1986, ACS Executive Director John K Crum met with the Corporation Associates Executive Committee, and requested that they prepare a "white paper" on future trends in the chemical industry, which would figure into ACS strategic planning efforts.

Corporation Associates proceeded in developing a survey for its member companies, with input from ACS marketing staff. This document contains the following material:

TAB 1 - EXECUTIVE SUMMARY

TAB 2 - SURVEY DATA

TAB 3 - KEY REFERENCES

The survey data is enclosed to provide the ACS Board of Directors an opportunity to get a feel for the wide range of individual comments received from this survey. Please respect the confidentiality of these responses.

ACS Corporation Associates is committed to a continuing dialog with chemical professionals towards identifying industry trends in the evolving chemical enterprise, and charting their strategic implication for the science and profession of chemistry.

We welcome opportunities to assist the American Chemical Society in their ongoing planning activities.

Corporation Associates is the formal link between the American Chemical Society and the chemical industry. Nearly 140 companies are affiliated with the ACs through membership in Corporation Associates. They include virtually all of the top U.S. chemical producers, as well as many outside the traditional chemical industry including Coca Cola, IBM and General Motors.

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"TRENDS IN THE CHEMICAL INDUSTRY"

An Executive Analysis of the

(March, 1987) Survey of

ACS Corporation Associates

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## I. EDUCATION

A significant majority of the company representatives are generally satisfied with the quality of recent graduates in the chemical sciences and engineering. It is frequently observed that technical preparation has improved over the past decade, though additional attention could be given to developing a broader educational experience, imparting skills in problem-solving, communication, management, and better familiarity with other scientific disciplines. There is the sense that more universities and colleges might offer a curriculum in industrial chemistry, stressing the commercial or applications aspects of the field.

Increasingly widespread is the interdisciplinary approach to R&D challenges. Teams of scientists and engineers with differing backgrounds now tackle problems in a collective way.

Considering the nature of this work and this mode of action, virtually all corporations have established vigorous in-house training programs to keep employees' skills sharp.

## II. SCIENCE

Within industry, the science of chemistry--while not about to lose its identity--is being evermore intermingled with other disciplines in the pursuit of new endeavors; for example, biotechnology, materials science, polymers, organo-metallics, separation sciences, expert systems, etc. (It would appear that this shift away from traditional operations into specialty fields is characterized by a rather sharp focus on gaining market share in a finite and limited number of areas--principally those listed immediately above.)

While this trend is virtually universal, there are some expressions of concern regarding possible adverse impacts that this redirection of effort might have on established areas of chemical research expertise and specialization.

In view of the greater sophistication and depth required for some areas of research, now commonplace are partnerships with other organizations (primarily universities) for the conduct of non-proprietory joint research.

Overall, research funding has been stable over the recent past; development activity, however, tends to be up over this period. The future holds more of the same with research becoming increasingly applied and the focus of work increasingly near-term, lower-risk, and results- (or bottom-line) oriented. It appears that this pressure to produce is one result of the current "competitiveness" push.

## III. SCIENTIFIC INFORMATION REQUIREMENTS

The clear consensus of opinion on information requirements and trends is that there must be more of it and that it must be available electronically. Bigger, faster databases are being demanded, covering the full spectrum of knowledge in the chemically-related sciences here and abroad. The rate and extent of change--in the words of one respondee--have been "dramatic," "...a revolution," in the words of another.

Data banks are being developed or expanded to an unprecedented extent, increasing emphasis is being placed on gaining timely access to information on international scientific developments. In-house and remote on-line (Chemical Abstracts Service is the most often cited.) information services are being deployed to a degree that could result in the displacement of most journals and other printed reference documents within about five years.

Senior corporate management is fully behind this move to more and better (electronic) information sources in support of research and development.

## IV. MANPOWER

Only modest change has been experienced--or is anticipated--by Corporation Associates under this category.

The spectrum of degrees for new hires remains essentially the same, though there is a slight increase in Ph.D. recruiting by those organizations pursuing a fundamentally new line of research. Relatively few problems have been encountered in locating and hiring qualified U.S. citizens.

Programs for the placement or retention of retired chemists are rare to non-existent. While some companies do hire former employees on a consultant basis, there is no evidence of a widespread or concerted effort to secure the services of retired or displaced scientists.

Regarding R&D expenditures, it is generally observed that they will be gradually growing--both in real dollars and in percentage of sales--over the next five years. Thus, demand for scientific personnel should remain strong through this period.

## V. PUBLIC IMAGE

There is a widespread sense that the public image of industry has deteriorated and could continue to deteriorate, though--barring serious mishaps--at a slower rate. Awareness of image problems becomes more acute for companies primarily engaged in chemical production, entangled in waste or pollution controversies, or otherwise perceived as threats to the environment. Conversely, companies being transformed into "high-tech" enterprises expect to experience a more favorable public perception.

There is a general call for a step-up of educational and communication activities, which would identify and promote positive aspects of the basic and applied chemical sciences, thereby helping to counteract the negative tone found in much of the media coverage.

## VI. INTERNATIONAL PERSPECTIVE

International science and technology communications are on the rise. As the technical sophistication of other countries increases, there is a growing awareness of worldwide competition in the marketplace. Corporate plans for product development and sales address more global characteristics; a shift in emphasis that has emerged over the recent past.

A few organizations report shifting production operations abroad to take advantage of lower-cost labor or materials. Research, however, retains its domestic (U.S.) base.

## VII. ACS IMAGE

Overall, corporate management is aware and supportive of the American Chemical Society, with knowledge of and support for the ACS tending to increase as one approaches the technical divisions of the companies.

ACS is seen as a competent professional scientific society providing needed services to the chemistry community.

An occasional observation suggests that the ACS could be more dynamic, more innovative in its activities, publications, and meetings.

## TRENDS IN THE CHEMICAL INDUSTRY

A Compilation of Individual Responses to the (March, 1987) Survey of ACS Corporation Associates

### I. EDUCATION

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A. DO YOU FEEL THAT RECENT CHEMICAL GRADUATES ARE MORE OR LESS PREPARED FOR THEIR JOBS, ESPECIALLY IN THE NEW TECHNOLOGY AREAS (E.G. BIOTECHNOLOGY MATERIALS SCIENCE, ELECTRONIC CHEMISTRY), THAN IN THE PAST?

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Better trained on fundamentals, new techniques, computer methods (1)

In the new technology areas it appears that chemical graduates (PhD) are more prepared to address advances. However, much more progress needs to occur. The creation of academic (interdisciplinary) centers of excellence may be the (rapid) solution to this problem. (2)

Less prepared. Quality of training is poorer. Most go to industry but no training to prepare them for industrial careers. Too many narrow specialists produced; students don't see the "big picture." (3)

Cannot comment - no experience (4)

Some very well, others not so well. There are large individual differences. (5)

Only partially. Most new PhD/MS graduates are not prepared for industrial R&D & require 1-2 years of incubation period. (6)

We are able to find some who are better prepared than in the past. (7)

Yes, technically, recent chemical graduates are well founded in technical areas. Improvements in intangible characteristics would greatly increase their ability to make significant contributions to our programs. They need to develop a sense of urgency about their efforts, cultivate their analytical thought processes more thoroughly and develop their skills in designing experiments to test their theories. (8)

No. (9)

Yes, the training seems to be better in preparing students for a career in industry (10)

In their area of specialization, the level of recent graduate preparation in chemistry is similar to past years. However, graduates are often not well prepared in broad science areas. (11)

No way of knowing. We do not deal in the new technology areas mentioned. (12)

We have not been hiring many chemical scientists recently. The few we did hire were all right. (13)

no change (14)

I feel the chem graduates are adequately prepared for the traditional job functions - the new technology areas are suffering because of poor curriculum planning at the university between departments, plus industry has not defined needs yet! (15)

Synthetic organic chemistry - more (16)

Academically, recent graduates are very well prepared for their entry into industry, especially from the recognized schools that emphasize academic excellence. We have had minimal experience with graduates in biotechnology, electronic chemistry, ceramics, etc.; however, we have been pleased with the quality of graduates in polymer engineering/science, and materials science. The major drawback I have felt for sometime is that academia should provide more opportunity for the student to learn what industry expects in terms of performance standards and real, practical demands in the world of work. Of course, maybe industry should assume some of this responsibility. (17)

About the same - good from the good schools, and less well prepared from the lower ranked schools. (18)

The best one are more prepared. Most are less prepared. (19)

Better prepared in computer-related areas; Less aware of "classical" organic and physical chemistry. (20)

About the same or slightly less well prepared. There appears to be improvement over what it was 5 years ago. (21)

In general, the recent graduates, especially those with Ph.D. degrees, are much better prepared and better informed than those entering the job market in the 70's. At the lower level, the quality varies a great deal but overall a marked improvement can be seen there also. (22)

Yes and no. Generally, new graduates are very well trained in their technical specialty but lack some important skills in areas outside the major field. American-born graduates have (generally) unsatisfactory communication skills. Non-American born people have (generally) excellent writing skills but some have accents which interfere with oral communication. I believe graduates would be more valuable with broader education and could improve skills in major field after employment. (23)

We are a small company and don't hire new chemists that often - particularly recent graduates. The few we have are very well prepared. (24)

No change. (25)

Good for conventional chemistry and engineering, less so for the new technology areas. (26)

About the same. (27)

They are not as well grounded in the fundamentals of chemical science, i.e., thermodynamics. Another specific example - more than 90% cannot tell me what the phase rule is. Moreover, they do not seem to be particularly skilled in any of the "new" technology areas. (28)

Examples above not in our technical area - adequately prepared in general background chemistry. (29)

More prepared. (30)

Better trained in instrumentation and computer use, but far poorer in basic chemical skills and knowledge. (31)

Less in the sense that more chemistry graduates will be working in non-conventional environments. (32)

Much depends on the intelligence/achievements of the individual. Care is needed in the selection of new employees who are recent grads. Good graduates are good employees with adequate preparation. (33)

New graduates are better prepared in new technology; however, quality varies. (34)

No significant differences, but some trade-offs. Those who have attained competence in a new technology area (i.e., biotechnology) are sometimes found to not be as well prepared in, for example, synthetic organic chemistry. (35)

Better prepared in biotechnology. (36)

Less prepared - graduates need more interdisciplinary training. (37)

Yes, current curricula in chemistry has a much wider scope than a decade ago due to the great advanced in the science. Comparisons to the chemistry curricula of the 1960's may not be possible due to the surge and expansion of the science. Of course, closer cooperative efforts between industry and academia is something the Corporation Associates can assist with through meetings and discussions. (38)

Most schools are doing a better job of training for applied science areas, but fewer chemical graduates are well trained for available jobs. Biotechnology jobs are going to graduates from biology and related programs. Most chemistry programs are training for traditional jobs and are not adequately preparing graduates for new technology or innovative science. (39)

Level of preparedness is essentially the same. (40)

For the most part, better prepared than in the past. (41)

Less prepared: current curricula provide no background in above areas (I would add Polymer Science to that list), yet many jobs exist for these fields. (42)

No opinion. (43)

No significant change. (44)

Recent graduates are as capable and motivated as in the past, but probably less knowledgeable on the overall scope of new technology areas (e.g., biotechnology, materials science, and electronic chemistry). These new technologies are moving so rapidly that it is understandably difficult for college educators to condense the knowledge of the trade to a curriculum. (45)

Probably as well as in the past, except possibly in the area of written communications. Recent graduates appear to have somewhat better perception of industrial research. (46)

I feel current graduates are less prepared. My concern is not their knowledge of the above highlighted applied areas but their grasp of basics and their communication skills. (47)

The present day graduates are prepared to about the same degree as earlier graduates for their jobs. (48)

We have never found that chemical graduates, now and in the past, were prepared for their jobs. Of course, the new graduates are more aware of biotechnology, etc., because of the new field of study. We find it is necessary to train recent graduates in the chemical disciplines related to analytical needs in the packaging and processing industries. (49)

No significant decline. Generally well-trained and aware of new technology areas. (50)

They are less prepared now. (51)

B. WHAT ARE YOUR COMPANY'S CURRENT NEEDS AND PERCEPTIONS OF THE AVAILABILITY OF APPROPRIATE CONTINUING EDUCATION FOR CURRENT CHEMICAL SCIENTISTS?

Needs being satisfied by local universities (1)

Need - 1) general education, 2) highly specialized courses, 3) scientific writing. Availability - 1) general education available through local universities, 2) highly specialized courses is (partially) addressed through ACS, etc., short courses. It would be desirable to offer courses in Computational Chemistry (possibly by CRAY), 3) Scientific writing needs to be addressed by academic institutions. "Learn by doing" is not appropriate mechanism in this case. (2)

Adequate courses are available from external organizations and universities. (3)

Internal courses exist; external courses are recommended. All employees are encouraged to attend. (4)

Seems to be in balance. (5)

More graduates in Polymer Science & composite science. (6)

We have a continual need & find adequate courses to supplement what we do in-house. (7)

Chemical scientists who are sucessful have the above intangible skills but lack technical know how, e.g. many new analytical techniques, are available today which were not available ten years ago. (8)

We have our own training programs and do send people to workshops and seminars. College students need more industrial exposure (9)

There are, of course, continual needs to keep scientists current. The most popular approach to accomplish this is via 1-10 day educational programs put on by outside agencies such as the ACS. In this situation rarely does one find a good match between programs and needs of the individual. (10)

The ACS courses are certainly readily available locally and/or nationally. More effective formats for all continuing education must be sought (for example, learning in stages rather than in a short, concentrated time). In some technical areas, too many course options are available, making recommendations of "which one" difficult. (11)

Adequate. (12)

Education is a continual requirement. (14)

Good. (15)

Literature, professional meetings, academic and industrial contacts satisfactorily fill the needs of the motivated chemist to remain up-to-date. (16)

Our needs are less for traditional chemistry and chemical engineering skills but there is more focus on computer applications, materials orientation, automation, creativity and involvement in esoteric technical areas. It is perceived that there are appropriate continuing educational programs for scientists to maintain their competency levels or retrain in other areas to avoid technical stagnation. (17)

Adequate. (18)

Ability to train themselves in new areas. Broadening to materials (19)

The supply of well-trained chemists is good. Our oldest chemists do not all respond well to retraining. (20)

Continuing education is needed and available. (21)

Most employees are being trained in-house if they are chemists for the biological aspects. Many attend night courses at local universities which is company supported. We have the trainees attend courses, lectures, and meetings at our discretion. In addition, we conduct in-house courses for various topics either by in-house personnel or consultants. (22)

We do considerable in-house training of our people. On an average, each employee spends about seven days in in-house training. Generally, we employ outside people to provide these course lectures. We generally send people to outside training programs maybe one per employee every other year. These range from 1 to 2 day programs to 3-month programs to 2-year sabbaticals (see below). (23)

The issue doesn't get any attention. (25)

Need more multidisciplinary people - polymers/materials, electronics/chemistry. We are hiring experienced people or training and continued education. (26)

Not enough - need more ACS courses particularly for in-house use. (27)

Continuing instruction, updates, etc. in: colloidal chemistry and physics; surface science; surfactant chemistry; specialty polymers.(28)

Definite lack of candidates available with training in polymer science and surface chemistry. (29)

Over the past few years we have had few needs in the area of continuing technical education. Those that existed have been satisfied by short courses, workwhops and seminars presented by universities, ACS and other institutions. (30)

Specialized training in engineering applications and plastics - readily available. (31)

In our case - improving because local institutions have begun to value this as a source of income to support their program. (32)

Continous courses, etc., often are a function of location, e.g. near universities, large ACS sections. etc. I believe the ACS programs are appropriate and good - tapes etc. (33)

We have in-house training program, we also encourage people to take courses in local universities. (34)

Local universities are probably the best source for continuing education. However, there certainly is no shortage of available external courses, most of which are useless except to expose the subject materials. Probably the most pressing need is retraining of experienced chemists in new areas. (35)

Adequate options exist for continuing education - short courses, international/national meetings, on-site training courses. (36)

This question is hardly clear. (37)

We feel that the needs of our chemists are being met through offers of the society and the various universities with various continuing education courses. (38)

Most company scientists are unwilling to take continuing education programs away from home for more than two weeks. A recently available program in medicinal chemistry is popular because it teaches new science, uses top teachers and lasts for one week. Our company sends scientists to many meetings, but very few to continuing education programs. It is easier to hire a new employee with appropriate training than to retrain, unless there is high personal motivation. (39)

Due to the dramatic increase over the past decade in specialized short courses we find the availability of continuing education more than adequate. (40)

- (41)

Continuing education is very important; not very available. (42)

Needs - 1. Technical - new areas, e.g., Biotechnology; 2. Managerial - general (43)

Continuing education is readily available. (44)

We believe there is always a need for continuing education. In the above memtioned new technology areas, "on-the-job" training is probably the best available form of education due to the dynamic and proprietary nature of those technologies. (45)

There is a strong need for continuing education. Many possibilities are available. (46)

In our area there are several excellent programs. (47)

We foresee current and future needs in various hazardous waste areas from basic research to knowledge of regulations, to designing facilities for processing waste. Educational institutions should offer courses and advanced degrees covering the environmental field. (48)

We have made use of a variety of seminars as well as continuing education facilities, e.g., IIT TV classes, to insure that our staff is current on technologies and equipment advances related to our continuing needs for improved problem-solving as well as improved productivity in R&D. (49)

In favor of continuing education. The need is being met moderately well. (50)

We continue to need graduates well educated in analytical chemistry! (51)

C. DOES YOUR COMPANY PROVIDE ADDITIONAL TRAINING AND EDUCATIONAL SERVICES TO YOUR TECHNICAL STAFF? IF SO, PLEASE INDICATE THE NATURE OF THESE SERVICES (I.E. IN-HOUSE, ACS COURSES/MATERIAL, CONTRACT CONSULTANTS).

Yes - all of the above (1)

See I (B) (2)

ACS courses (internal and external), consultants, special contract courses, IRI, others. (3)

Same as B. (4)

Yes. Internal as well as external. (5)

In-house & contract consultant courses. (6)

Yes. In-house, ACS material, & occasionally contract consultants. (7)

Yes, funding is available for participation in ACS courses. (8)

In-house courses. (9)

Same as B. (10)

Additional training/education is quite extensive. In-house courses, ACS courses, and cooperative course development (industry & university) are used. This is an important topic. (11)

Employees may request that they attend any outside courses by course. ACS courses are available in-house. Tuition is refunded for course attendance at local universities. Contract consultants used only rarely for in-house courses. (12)

Yes. Mostly in-house and from nearby educational institutions. (13)

Yes. In-house. External. (14)

All avenues (15)

Yes, consultants, lectures and courses (16)

In-house training courses are provided to upgrade skills, such as oral and written communications, decision making, negotiations, time management, etc. as well as supervisory and managerial training. Tuition refund program supports technical training and employees attend conferences, seminars, and courses conducted by ACS and other technical organizations. (17)

Yes. In house courses; TAPPI courses; outside consultants, etc. (18)

Yes all of the above. (19)

Yes. Company courses, tuition refund for courses at local universities. In addition the division provided courses in Heterocyclic chemistry (E. C. Taylor) last year and will give a course in NMR spectroscopy (G. Bushtold), this fall as part of an upgrading program. (20)

Yes occasional of in-house courses, nearby university training and courses, ACS courses, and non-ACS courses. (21)

See above. (22)

See above. (23)

Contract consultants - particularly managerial skills (24)

Primarily ACS course material. Secondary, consultants. (25)

Yes; university, regional courses, consultants, self-training. (26)

In-house ACS courses - we're one of their best customers. Computer-aided instruction; outside consultants; in-house specialists give courses. (27)

In-house course on surfactants and surface science; contract consultants; liberal use of ACS courses, meetings, seminars, etc. (28)

Tuition aid for independent studies. (29)

In-house courses are offered in management training, financial management and an array of non-technical courses. Several courses related to exploration and production are provided to those working in that area. ACS courses have been used to train technicians. (30)

Mostly use outside university courses - few ACS resources. (31)

In-house - especially interpersonal relations consultants for 1 day or multi-day courses. (32)

Contract consultants, ACS courses/material, associations with local universities, etc. (33)

Yes -- in-house, ACS courses, contract consultants, vendor presentations. (34)

The company provides:
- o In-house courses for all levels of technical staff
- o Financial support for university studies
- o Financial support for ACS/AIChE courses (35)

Yes, in-house seminar series of invited speakers occasional on-site training courses ACS short courses, local college/university afternoon/evening lectures. (36)

Yes, but again the question is not clear (e.g., technical, managerial, entrepreneurial, etc. (37)

Yes, the Research & Development Department offers a wide range of opportunities. We have in place a Visiting Scientist Program. Consultants are widely used in specific areas of expertise. An in-house weeklong workshop will be held in the use of CAS Online services this June. A wide variety of in-house development courses are available. Lastly, the opportunity to attend "short courses" or regular university courses at company expense in a routine benefit. (38)

Yes, occasional in-house courses, consultants, and ACS tapes. (39)

Low level of in-house educational services. We fully subsidize formal and informal outside education. (40)

Yes, in-house and outside services. (41)

Outside courses & seminars; in-house courses (somtimes for credit). (42)

In-house - managerial - usually run by consultants (43)

We have in-house training courses, ACS video courses (self study) and we support employees taking outside courses at local universities by paying tuition. (44)

We provide training and education to all of our employees. This is done by a combination of (1) in-house training sessions, (2) courses offered by other institutions (ACS, AIChE, universities), and (3) training courses provided by contracted outside firms. (45)

Yes, in-house courses, ACS short courses, audio and video courses, various technical courses offered by universities and private organizations. (46)

Yes, mainly in-house and selected seminars and symposia in specific areas of interest. (47)

Yes, in-house courses, tuition refund at local universities. (48)

Yes, technical courses, in-house and other technical seminars, ITT TV classroom broadcasts to our R&D facility. (49)

Actively promoted. Have used ACS materials in the past. Technical staff participates in in-house as well as outside courses. (50)

Yes, we use in-house (some) and some contract work. Occasionally the ACS courses, but these are usually too superficial for our analytical chemistry needs. (51)

II. SCIENCE

A. DO YOU SEE THE NATURE OF YOUR CHEMICAL RESEARCH EXPANDING TO EMBRACE A MORE INTERDISCIPLINARY APPROACH? IF SO, CAN YOU INDICATE THE NATURE OF THE INTERDISCIPLINARY EFFORT? WILL CHEMISTRY CONTINUE TO HAVE A "SCIENTIFIC IDENTITY" OR BE ABSORBED INTO OTHER DISCIPLINES?

Yes - moving more towards materials science and away from strictly chemistry. (1)

Chemistry is essential to most interdisciplinary areas. It cannot be absorbed into other disciplines because of the need for specialists. Although areas such as bioprocessing, plasma applications, energy research, etc., are viable areas, each requires the chemical specialty (kinetics, thermodynamics, measurements, etc.). (2)

We often place several disciplines in a team with a single research or product development goal. Chemistry will continue to have its own identity although most chemistry disciplines will have a "bio" prefix -bioanalytical, bio-organic, etc. Genetic engineering successes will depend on input from synthetic organic and analytical chemists. (3)

Organic - biochemistry - analytical (4)

Teams of experts in various disciplines are often used now. (5)

Yes. (6)

Our research remains primarily in the classical areas with, perhaps, some increase in involvement of chemical physics & chemical engineering. I believe chemistry will continue to have a "scientific identity" for many years to come. (7)

Specialization appears to be even more extensive today. Researchers have greater difficulty in maintaining a current knowledge of their specialties and accordingly, have little time to expand their interests into other disciplines. An applied or development chemist expands into other disciplines at the expense of his chemistry background. (8)

Yes, physical, analytical, applied etc. Yes, chemistry will continue to be absorbed into other disciplines. (9)

Yes, most research is currently interdisciplinary. In most cases the chemist has the more fundamental role and picks up enough knowledge to successfully interact with other specialists. It has been my experience that knowledge of chemistry fundamentals is still very relevant in obtaining project goals. (10)

Our research already requires significant interdisciplinary approaches, and this will continue. We feel a chemical viewpoint is essential for

realistic improvements in materials science, biotechnology, and electronics. Biology, for example, is becoming a chemical science. In a 35-year career, a good basis in chemistry is one of the most effective springboards for learning and contributing to new areas of technology within industry. (11)

Yes. No. Yes. (12)

Since we are not a chemical company, by necessity our personnel with chemical background are involved in what may be broadly defined as interdisciplinary activities. (13)

1) Yes . 2) Involves 12 skill groups: Prefer not to expand.
3) Yes (14)

Yes, but a new subset of interdisciplinary training will emerge plus a new project leadership role. (15)

Chemistry is certainly expanding and unless it takes a strong leadership role, it will indeed be absorbed into disciplines that it "services" (16)

Chemistry will continue as an entity but will become more of a means to an end rather than the end itself. Systems will evolve in which chemistry is key but the product will be the system. Interdisciplinary efforts will involve composite structures, electronics, inorganic chemicals and ceramics, and improved performance characteristics will come mainly from the chemical component. (17)

No. Chemistry will certainly remain with its own identity (18)

Yes. More in complex systems & materials. Chemistry will be a discipline largely unified by a style of thinking. (19)

Our interests have always been interdisciplinary, due to the nature of our business, photography. The "chemistry" identity is strong. (20)

Yes - Chemistry will continue to be more interdisciplinary especially with regard to the biological sciences. I do not believe chemistry will lose its scientific identity. (21)

Absolutely. A productive chemist in this industry must understand the biological aspects of the business. Drug design requires understanding of reception life and molecular modeling. Beyond that, the young chemists must be cognizant of bioengineering and use discretion regarding what is synthetically feasible and what is better turned over to the recombinant group. (22)

We are in the materials business. Our manufacturing operations are very chemical and ChE-oriented. Our products are oriented to the industries they serve. Our R&D is oriented to processes (chemical) or to skill centers with names like polymerization, ceramics, agriculture, adhesion, etc. 30% of our people are professional chemists or engineers by training but now would list their occupations as other disciplines. (23)

Our area of work - carbohydrate chemistry - is still pretty much an identity of its own. (24)

No. Chemistry will continue to have its identity. (25)

Yes - see above - more physics/chemistry/electronics/polymers, materials science and processing. Chemistry will have a scientific identity probably as part of a "team" effort. (26)

We are moving toward interdisciplinary approaches particularly in biotechnology. Chemistry will continue to predominate. (27)

Chemistry will continue to have a "scientific identity." (28)

Not except into engineering. Continuing identity. (29)

Yes, we are seeing an ever increasing integration of computers into our chemistry and chemical engineering programs. The integration of materials science with chemistry also appears to be a trend. The use of biotechnology in synthesis is already here, but there is plenty of room for expansion. Chemistry will always have a scientific identity, but it will be used in conjunction with other sciences where necessary. (30)

Not for the next decade - I think chemistry will retain its identity for the next 20 - 30 years. (31)

Yes - chem will remain a core science but more and more research will involve applications involving biology, solid state electronics, materials, etc. I do not believe the majority of these will become core curricula in their own right. (32)

Yes, chemical research is expanding - for us more and more into the needs of downstream products. I hope chemistry continues to have an identity - I believe it will but will vary i.e. can a small university with a small university with a small enrollment have a distinct chemistry program. Industries may discover the "critical mass" of chemistry needed. (33)

Yes, in our company most work is inter-disciplinary. Chemists work with Material Scientists, Electrical, Mechanical, Chemical and Computer Engineers. (34)

No question that chemical research is becoming more interdisciplinary and, to some small degree, losing "scientific identity". Who cares! Clearly, I do not support chemistry for the sake of chemistry. (35)

In the pharmaceutical industry, chemistry will be identified in the synthetic and analytical phases, but will blend a strong component into "biological" aspects of R&D. (36)

Yes. Traditional chemistry disciplines will becomes increasingly blurred. (37)

Chemical research, here, has become interdisciplinary due to our use of the project team approach to investigate new areas of technology or solve problems for the Company. Chemistry will serve as the central science around which the other scientific disciplines will absorb new interdisciplinary "sciences" such as biochemistry. (38)

Definitely more interdisciplinary. Synthetic chemistry involves proteins, polysaccharides and nucleic acids, often linked to selected small molecules. Although biological sciences are playing a greater role in the discovery task, synthetic chemistry and the determination of physical and chemical properties will always be important and require increasing sophistication. (39)

Most chemical research now has a regulatory aspect (FDA, EPA, etc.). (40)

No. (41)

"Chemistry" will continue to have its own identity, but the area it embraces will be multidisciplinary. Examples: biotechnology; genetic engineering; materials science. All are "chemical", but with other technological components as well. (42)

There is a need for an interdisciplinary approach, e.g., biochemistry, biotechnology. But the need for chemistry alone also continues. (43)

Yes. The effort includes materials science, especially polymer science, surface science, etc. Chemistry will continue to have "scientific identity." (44)

An interdisciplinary approach has already been a way of life in our research. We are in business to provide solutions and performance to our customers, rather than to just sell chemicals. A complete solution on performance often requires the combined skills of chemistry, physics, electronics, and engineering. Nevertheless, chemistry is always an indispensable part of a total solution and we believe it will continue to be a "scientific identity" because it is so important and so fundamental. (45)

Industrial research tends to be interdisciplinary. Most problems are not strictly chemical. Particularly in a small laboratory, individual scientists have always had to become involved in other disciplines. Chemistry will retain its identity - it is impossible to have in-depth training in multiple disciplines. Chemists and other scientists must be willing to learn about other disciplines as necessary, and know when to consult with experts in those other fields. (46)

I don't know what you specifically mean by interdisciplinary approach. However, we are certainly seeing the need for our chemists and engineers involved in research to work far more closely and effectively with other functions in our company (i.e. engineering, manufacturing, marketing, sales) and also our customers. (47)

We have an interdisciplinary approach at present which will probably remain as such for the future. An example of this type of effort is

our combustion/gasification/pyrolysis research which includes mechanical and chemical engineering disciplines as well as research chemists. Chemistry should continue to have its own identity. (48)

There has been an interdisciplinary approach at our laboratory, and we insist upon it, in our areas of chemical research. We make sure all technologies within the laboratory are used as a basis for an interdisciplinary approach to problem solving. (49)

Increased interdisciplinary nature. Increased involvement of biotechnology and computers. Chemistry will maintain its scientific identity. (50)

Both will be important. It is too complicated for a survey question. (51)

B. IN PURSUIT OF RESEARCH, DO YOU SEE MORE PARTNERSHIP EFFORTS WITH UNIVERSITIES, GOVERNMENT, CORPORATIONS AND SOCIETY IN GENERAL? PLEASE ELABORATE.

Yes - Already doing more with universities and other companies - but more slowly with government (1)

Our organization is a captive USDOE contractor. The efforts associated with this agency are directed toward partnerships in all arenas. (2)

See more partnerships with universities but not with others. (3)

Yes - We have a Director, External Research, pulling these interfaces together (4)

Some cooperative or joint R&D efforts are part of our efforts. (5)

Not as much as it should be done. (6)

Our company is definitely exploring moves in that direction, albeit on a small scale. (7)

No, a strengthening of our patent laws has and will continue to encourage private industry to hold secret their significant commercial, scientific work. (8)

We have proprietory arrangements. (9)

Yes. It has been my experience that there is an increased understanding of the needs of each of these 3 segments. Better understanding usually leads to better integration of effort. The role of the coordinator is the key. (10)

In our company, many partnerships have been announced in the past two years. These will continue. Nearly all of these are with other corporations and/or universities. Presently, direct partnerships with government laboratories seem to have too much "red tape" associated with them to be broadly implemented; we do, however, feel such interactions are desirable. (11)

Yes - as research tools become more expensive & elaborate & more specialization is required, it makes increasing sense not to duplicate efforts in industry & academia. (12)

Yes. We are shrinking internally and supporting university research more (in areas of interest to us) (13)

No - about the same cooperation with universities restricted to individuals (14)

No - too many real and perceived barriers - only hope is companies/universities. (15)

The cost of research and development to market a product is so great that collaborative efforts will become more common if not essential. I believe this will be greatest in areas of development, not research (16)

Yes. Grants-in-aid will increase to universities who specialize in emerging technologies such as ceramics. Closer attention will be given to government-funded programs in which corporations can be in "partnership" with government. Corporations will increase the number of joint development programs in which each partner brings expertise to an emerging joint business interest. (17)

Yes. A useful way of getting access to proposeful basic research. Very cost effective, but nonproprietary, of course. (18)

More with universities. Other interactions will occur much more slowly. (19)

Yes, because of financial constraints, especially because of the cost of instrumentation. (20)

Yes - brought about by: 1) universities getting more involved in applied research - patents, etc. 2) social and governmental pressure for "safe" research - re: biotechnology, pollution, working conditions 3) social and governmental pressure and concern for animal welfare (21)

Yes. We have joint ventures with at least half a dozen universities, two biotechnology companies, and two ventures with the U.S.A MCRDC. (22)

Absolutely. We are formulating many joint R&D programs with customers or potential customers. We do alot of exploratory work with university professors. We do government supported work in areas where we believe the time to commercialize is very long. (23)

We do joint ventures now mostly with corporations or start up high tech firms. (24)

More partnership efforts with universities is likely. Governments new policy of licensing results of their R&D programs will lead to greater utilization by industry. (25)

Yes. (26)

More cooperation. We have several ongoing programs. (27)

Our corporation uses several "partnership" efforts with the academic community - these will continue and grow modestly. (28)

Yes, but mostly corporations. (29)

Yes, the government (e.g. NSF) seems to be pushing this type of thing. Universities and government laboratories are encouraging technology transfer. The Gramm Rudman Act, which is reducing government funded R&D, is pushing universities to industry for support. (30)

Yes - we are more involved in joint research agreement - other corporations. (31)

Yes, but universities must show a willingness to move in direction of more applied research and there must be mutually accomodative movement on patent & publication rights. (32)

Partnerships will become more common as divergent or different knowledges are required for projects involving different disciplines. (33)

Yes, our corporation work actively with universities, consulting laboratories and other companies. (34)

Absolutely! Any research manager worth his/her paycheck will be looking to leverage research dollars with those from university and governments, perhaps on the more "basic" aspects of a problem. As regards joint ventures, R&D partnerships, etc., with other companies, they will increase at an increasing rate. It's merely a question of economics and timing. (35)

Yes - 1. Cross-screening of chemical compounds between chemical companies in different businesses. 2. Use of more academic consultants 3. Increasing use of academic grants-specific and broad. (36)

Yes, it will be absolutely necessary for each community to form partnerships to leverage their resources. (37)

Yes. As the costs of research and development continue to escalate well above any inflation level and more precise scientific specification causes "gaps" in staffing, partnerships are "must." The Japanese system obviously must be considered with the intimate relationship of industry, government, and academia producing such great advances. (38)

Yes. Government scientists are collaborating more in applied science and development, and more of their research is being put out for collaboration bids. University research is being patented more effectively, which makes collaborations between universities and industry more frequent. Industry is also starting to tell its story to society, which will improve its image. (39)

- (40)

Somewhat. (41)

I see no significant increase in such partnerships--they are expensive, time-consuming, and results are (often) of questionable significance to the corporation. (42)

Yes. New technology requires closer liaison with experts in universities. (43)

Yes, we will have more contracts and joint research programs with universities (44)

Yes. In this increasingly competitive world, technical excellence has political, economic, and social implications that are beyond the financial merit of private corporations. It is imperative that a nation combine all its available resources in the pursuit of R&D. The race of the fifth-generation computer between the U.S. and Japan is a prime example. (45)

Yes. Recent changes in the law have opened up partnership opportunities which historically did not exist. It also appears that some very expensive projects can only be handled in cooperative ventures between industry and government, for example, if we are to compete with overseas competitors that operate in this manner. (46)

Not in the last three years. Major expansion of these activities occurred in the late 70's and early 80's. (47)

This trend has been in effect for a while now and will continue. It is very common for our company to do work for government (DOE, EPA, ect.) in the areas of advanced combustion technology, synfuel and environmental protection. We participate in the "National Science Foundation Industry/ University Cooperative Center for Research in Hazardous and Toxic Substances." (48)

We expect more partnership efforts between universities and industries as well as the government in pursuit of research as the economy continues to dictate that every organization find more effective, efficient and economic ways to implement their research needs. (49)

Perceive increased partnership effort between academia and business. (50)

Absolutely. We do several and have for many years. We should do more. But it is difficult to organize. (51)

C. HAVE YOU NOTICED ANY SHIFTS IN EMPHASIS IN SUPPORT OF RESEARCH COMPARED TO SUPPORT FOR DEVELOPMENT EFFORTS? HOW SO?

Yes - even at our own company we are doing more exploratory research (1)

Shifts to interdisciplinary research groups to address the "chain-linked model" that ultimately will replace the conventional "linear model" in research of large problems. (2)

In the last 20 years there has been a strong shift from basic to applied efforts in industry. By applied is meant product development. (3)

Shift is to the academic institutions for basic research (4)

No. (5)

More emphasis to development efforts to respond to the pressures of corporate profitability (6)

Not so in the overall picture for us. (7)

A movement to development is occurring within our organization. Researchers are tending to do incremental work which has a high probability of success with little but real financial gains. (8)

No. (9)

Yes. It is currently perceived that a future business advantage can best be accomplished by developing proprietary technology. (10)

High levels of "customer interaction" and "manufacturing cost" concerns presently emphasize development more than in previous decades. Although this shift may be cyclic in industry, there is also concern expressed that government funding (usually supporting basic science) is shifting too far toward applied science. (11)

We are (unfortunately in my opinion) moving increasingly toward development for short-term impact on bottom-line profits. I feel this shift away from research will have serious negative consequences for the future competitiveness of our society. (12)

Yes. There is a shift to "relevant, mission oriented" efforts. (13)

This is a complex issue. In direct response to the question; see no shifts. NOTE: Shifts have occurred over the last 15 years: away from development. (14)

Reawakening of need for basic research. (15)

Industry wants to make money, if not today, no later than tomorrow. This leads to short term goals and shifts to development efforts first, and research only if it can be afforded (16)

Technology assets are constantly changing, but the rate of change seems to be accelerating; therefore, many companies seem to be committed to spending a higher percent of their technical budget on basic research so new technology assets can be established. (17)

Fluctuates back & forth. No trend (18)

No. Changes within each but similar total efforts. (19)

When money becomes tight and hiring is curtailed the work closest to the product is the work most heavily supported. Research continues at a slower pace. (20)

Yes - trend toward development. I believe this trend is beginning to reverse at present. This research - development equilibrium will always be dynamic, shifting according to or in response to economic, social, political, etc. pressures of the times. (21)

Both have considerably increased. Obviously development will always take precedance over research for the simple reason that a company must stay profitable. (22)

Some definite trends to increase effort to find business in areas we have traditionally not been involved. This is clearly research oriented at the present. (23)

No. Our firm has always placed stronger emphasis on "developmental" research rather than "pure" research. (24)

No. (25)

In our company every little difference between the two. However, some increase in "frontier" type research. (26)

Increased support of university research. (27)

There has been a decided shift toward the "short-term" in R&D, producing a greater emphasis on development. Industry, where most scientists are employed, is not supporting enough longer-range research. (28)

More strict market orientation. More emphasis on product development. Less investment in long-term disciplinary specialty training. (29)

Yes, more manpower is being directed to technical service/development activities. There is less "long term" research. (30)

Greater emphasis on development shorter pay out. (31)

Increasingly, industrial support is available only for development. We may lament this but it is a fact of life as the belt tightens for the chem & petrochem industries. (32)

Shift over the past few years to cost efficiency environmental controls etc. Research is tough, the government charges for patents (we should get a bonus for commercial or outstanding concepts) TSCA PMN testing fees, registration fees, all make the "R" tougher. (33)

Yes, primary effort is on development of products than research. (34)

Research has remained relatively flat, while development has increased somewhat. Making good businesses better has a universal acceptance and development efforts often have that short-term effect. (35)

In periods of maximum R&D growth, most growth sends to go to research, as opposed to development. (36)

Always, varies with time. (37)

Yes, unfortunately economic reality has caused an enhanced concern for more rapid deployment of ideas into products which favors a larger "piece of the pie" for development. The public and scientific press is telling this story on a regular basis. (38)

The cost of development is much higher, and emphasis has increased for development. But the greatest frustration for a discovery scientist is inadequate development resources, so this trend should help discovery. Good development also offers direction for better discovery. (39)

Within our organization we have decreased the research effort and substantially increased the development (cost reductions) effort. (40)

- (41)

In the specialty chemical area, emphasis has shifted to development programs--away from research. Emphasis is on new products; the widespread feeling is that the key to company growth is clever use of existing data and technology. (42)

General shift from research to developmnt. (43)

More support for long range, rather than short range research. (44)

In the biotechnology area, we do see an increasing emphasis on development efforts. In other areas, we see little or no change between research and development. (45)

In our laboratory, support has been gradually shifting from research to development. (46)

Not in the past 3 years. In the early 80's there was a shift back to research which has been constant for the past 3 years. (47)

Government-funded efforts have shifted in support of developmental work and our government work has therefore followed this trend. (48)

On the contrary, the trend continues to be to support development efforts. The support of research requires a "champion" or "salesman" to be able to sell the long-term benefit of research vs. the short-term pay-off of development work. (49)

Important to maintain balance - no significant change in emphasis. (50)

Too subtle for a survey. (51)

D. WHAT TRADITIONAL AREAS OF R&D ARE BEING DE-EMPHASIZED? WHAT NEW R&D PROJECTS HAVE BEGUN (E.G. BIOTECHNOLOGY, AGCHEM, MATERIALS SCIENCE, COMPUTERIZED PROCESS CONTROL)? WHAT ARE THE NEW GROWTH INDUSTRIES IN WHICH CHEMISTRY WILL PLAY A ROLE?

We are actually adding, rather than replacing. Material Science is being increased as is passive electronics devices research, optoelectronics, etc. (1)

De-emphasis - alternate energy sources. Emphasis - 1) development and applications of superconducting magnets, 2) high temperaure membranes, 3) near net shape metal and composite casting, 4) direct ore reduction, 5) hazardous waste minimization, 6) space (extraterrestrial) power, 7) space (extraterrestrial) processing, 8) biosensors. (2)

Biotechnology is the growth area of the future and chemistry will play a central role in its success. Chemistry will continue to have a heavy role in agricultural chemicals and material science. Of the four major chemistry disciplines, inorganic seems to be in low demand. (3)

Too much emphasis on new growth areas. Our CEO & Dow's CEO have pointed this out recently (4)

Biotechnology, composite materials, pharmaceuticals. (5)

Exploratory & basic R&D is being de-emphasized. (6)

Synthetic chemistry, in general, seems to have been de-emphasized. Material science, robotics, remote sensor technology all seem to now play a big role in chemical R&D. (7)

New R&D programs are currently on the shelf with researchers investigating incremental improvement of existing materials. (8)

Not applicable to us. (9)

- (10)

All of the new areas mentioned are being emphasized. Chemistry will play a significant role in making bioscience happen. Shifts in traditional areas will occur. Consider the following (unofficial) estimates:
Organic Synthesis: the usual molecules, metallo-organic, organometallic
Analytical Chemistry: moving to solids & polymers
Physical Chemistry: traditional - on new materials & processes
Chemical Engineering: traditional - biochemical engineering (11)

No comment. (12)

- (13)

De-emphasized - none. GROWTH INDUSTRIES: Long Term: 1) Energy 2) New Building blocks (all chemical industries) 3) Materials (14)

- (15)

Areas of de-emphasis are industry dependent, probably even company dependent. My comments couldn't help. Certainly bio-tech and chemistry will be intimate partners as well as chemistry and materials science (16)

De-emphasized: Agricultural chemicals (liability of product use); commodity chemicals; any product containing a highly toxic raw material, in process moiety, or by-product.
New: composites; ceramics; expert systems; systems automation and control; inorganic polymer research.
New Growth Industries: High performance composites; innovative structures for medical implants; biochemistry; photonics as electronics replacement. (17)

None that I can see. New ones are being added; of the examples you quote, we are involved/invested in all except agchem. (18)

Commodities, unit operation processes, (all) medical products (19)

We have an effort in both biotech and materials science that is new (for us). I wish I knew what the new growth industries will be, but, alas, my seers are out to lunch. (20)

Deemphasized? New areas - computer assisted drug design, in addition to the above. New growth industries - biotechnology, materials science, separation science. (21)

Deemphasized is random synthesis and random screening. Considerable effort is placed on computer design, computer control and mechanisation in general. Biotechnology has been assigned a larger share of funds. In our industry primarily treatment of old age disease and delivery systems. Biotechnology has and will make substances available which previously were virtually unavailable for therapeutic use (growth hormones, many endocrine regulatory factors, etc.). (22)

These answers are proprietary. (23)

We are too small to really know what is being deemphasized. We see stronger emphasis on biotechnology. We are doing more in supplying building blocks for biologically active substances - e.g., antiviral compounds, etc. We are also taking close looks at automated process control and new process technologies. (24)

Biotech approach to crop protection will be increasingly important, as use of chemical agents. (25)

Catalysis, chemical process research. New R&D: opti-electronics, new materials, ceramics, blends and alloys. Chemistry will play a larger role in information, biotechnology, materials industry (26)

Biotechnology and electronic chemicals are new. (27)

Chemistry will play a role in just about every growth industry short of "financial services" and entertainment. In industry, basic research is being de-emphasized because it does not produce short term payouts. (28)

Less availability of new materials for exploratory research except in high tech areas. Hig product introduction costs due to regulatory and liability concerns. (29)

Areas being deemphasized: Exploratory R&D not directly related to current business areas. Synfuels research. New R&D projects: Separations, biotechnology. New growth industries: Gene manipulation & genetic engineering, synfuels (in a few years), membranes (materials), waste and hazardous waste disposal. (30)

- (31)

Numerous & that will be a problem because none will have the likely mass to be prime FOCLL for research support. Many will be willing to work with departments to find mutually beneficial programs. (32)

See analytical growing, organic about the same lot of aspects of P-chem not emphasized for us - becoming engineering
I believe grouth in chemistry will depend on economics - strength of dollar - and come at the expense of companies that exit.
I believe real growth will be very modest i.e. look at proposed registration fees for Ag. Chemical, all requirements for new pharmaceuticals. (33)

None of the above; we are getting more involved in fine particle technology. (34)

New areas: biotechnology, materials science and pharmaceutical intermediates.
De-emphasis: alternate energy sources.
Chemical sciences will be a significant contributor to those "new areas" listed above. (35)

Certainly biotechnology, which in turn will impact both medicial, diognostics and agricultural chemistry. (36)

o Materials science
o Automated process control (e.g., robotics, expert systems) (37)

The very foundations of chemistry in the industrial sector is changing. These areas are becoming more than ever the sole domain of academia or government-supported research. Chemistry will play roles in such areas as superconductivity research, specialized new compounds for pharmacological evaluation, etc. (38)

Traditional polymer chemistry, wet analytical chemistry, and some areas of synthetic chemistry are being de-emphasized. Computer-assisted drug

design, molecular biology, molecular pharmacology and immunology have taken an increased role. Biotech will play an increasing role in our company. (39)

- (40)

Material Science.(41)

Areas being deemphasized: inorganic, classical analytical and physical chemistry. New areas in those mentioned in Question II D above, and also including pharmaceuticals (controlled drug release), modern ceramics, and drug synthesis. (42)

De-emphasized - synthetic organic. Emphasized - biotechnology. (43)

- (44)

Energy-related R&D and process improvement for commodity chemicals are being de-emphasized. New R&D projects are being initiated in the biomedical, biotechnology, ceramics, polymer composites, and the separations science areas. Chemistry plays a vital role in all these areas. (45)

Fundamental research responsibility has been shifted more from industrial to academic laboratories. New growth industries - biotechnology, electronic materials, energy storage and transmission, materials science (whatever that means). (46)

In our company none have been de-emphasized, however we have expanded in computer applications and process control. (47)

We have been emphasizing environmental and energy conversion R&D (i.e., coal to clean fuels). We anticipate greater emphasis on our part in biotechnology, laser technology and robotics. Chemistry should be playing major roles in environmental and biotechnology R&D. (48)

Within the packaging area, we do not see any de-emphasis in the traditional areas of R&D. Certainly the application of computers to various areas of R&D has been greatly emphasized in recent years. Materials science is receiving greater emphasis in the face of demands for improved performance, improved package integrity and compliance with a multiplicity of government regulatory pressures. (49)

Traditional areas continue to maintain their position, but are being supplemented by new technology areas such as biotechnology. (50)

Biotechnology, yes. Computerization for us is cardinal. (51)

## III. SCIENTIFIC INFORMATION REQUIREMENTS

### A. HAVE YOUR REQUIREMENTS CHANGED IN THE LAST FEW YEARS FOR SCIENTIFIC INFORMATION, AND HOW DO YOU THINK IT MIGHT CHANGE IN THE NEXT FEW YEARS?

Yes, dramatically in amount available. It would be impossible without computer searching. (1)

The basic requirements for technical information remain the same. The rate at which the information can be acquired always needs to be increased. (2)

Need constant access to world's technical information. Information needs to be accessible in he lab/office rather than in remote library facility. (3)

More computerized databases being used. (5)

In general, computerized retrieval of information from vast data bases seems to be accepted by all scientists. Molecular design & molecular synthesis software will become even more important. (7)

I believe we are going to need better access to Japanese publications; e.g.; English translations of their basic research efforts. (8)

More use of data banks than on book materials. (9)

Yes, there is a growing dependence on computer searches because of the relevant published technical information. (10)

Clearly, new research areas (as in question II D) require new information. Our local research library cannot "instantly" become adequate in electronics and bioscience. The next few years will require good, cost-effective access to external (database) sources of information. (11)

No opinion. (12)

- (13)

Information searches (14)

Management of more than requirements for information (15)

Yes. The information pool will certainly expand. (16)

Our informational needs have changed considerably in the last five years. We have crossed over from traditional chemistry and chemical engineering sciences to multidisciplines and are following closely emerging

technologies with emphasis on "high-tech" areas. These trends have resulted in changes in journal subscriptions, book collections and newsletters including provision of marketing and business information for the R&D personnel. (17)

Yes. Need access to good databases & quick retrieval systems. Those that exist we are using (18)

More rapid access to large database. More of the same. (19)

The requirements have not changed dramatically. The way we meet them is undergoing a revolution. We still depend heavily upon Chemical Abstracts, current and academic journals. (20)

Increased and will continue to increase. (21)

Yes, we have run out of space to store journals and books. Most information is now stored in computers either in-house or on-line. An excellent example is CAS. This will continue to become more and more prevalent and the printed document will become a method of the past. (22)

Seems like information is more and more in demand. Should continue. (23)

- (24)

No. (25)

Yes; continued change for better abstracts and in specific areas - from the broad to the specific. (26)

Increasing by leaps and bounds. (27)

No. I believe the information explosion is under reasonable control. (28)

More need for theoretical training in specialized areas. Basic areas (of mass education) are well done. More information resources for scientific personnel retraining. Better access into newer disciplines by more accessable information. (29)

Yes, our needs for information have diminished because the overall scope of our R&D has diminished. Fewer R&D personnel forces those available to be more versatile and to seek out concise reviews of technology of interest. Survey reports are now purchased from outside agencies; few are prepared internally. (30)

Not significantly. (31)

Yes - more, more varied and more international. (32)

Most recent info with the communication std. has centered on top data. Use databases almost exclusively. (33)

We use on-line databases. More and faster information on foreign patents and publication will be needed. (34)

Yes, substantive changes have occurred and will continue to occur. Information from "world" databases are required in order to maintain relevancy. (35)

Rely more heavily on computer searches of multiple databases in preparing more frequent position papers. Will need databases which allow searching on meeting abstracts. (36)

Requirements unchanged but mechanisms to provide sci. info will change markedly. (37)

Yes. The reasons for the changes are at opposite ends of the spectrum. The ever increasing size of the body of literature has caused the mature scientist to seek the literature chemist as the source of information. At the same time, the new scientist with academic exposure to automated systems seeks to recreate that environment in industry. Thus, two different groups must be served and this requires more highly skilled literature chemists; to search more complex databases, to build databases, and to train" end-users. (38)

Much more electronic information, more posters at meetings, and more reporting of original data to the lay press. (39)

Requirements have not changed. Method of retrieval has dramatically changed to computerized search and retrieval. (40)

- (41)

The inevitable trend toward even more automation (42)

Information needed on new technologies, e.g., electrochemistry, biotechnology (plant tissue culture), etc. (43)

Requirements haven't changed though the method of delivery (i.e. on-line searches, microfilm, etc.) has made information gathering more efficient. (44)

There is an increasing need for gathering scientific information faster and in a better managed form. (45)

Requirements have not change but methods available have changed dramatically with new computer applications. (46)

No, except we are making it far more available with the computer. (47)

Our need for information has been in the areas it is emphasizing -- environmental and energy conversion. As we begin to emphasize biotechnology, laser technology and robotics we will require more information in these areas. (48)

The methods of retrieving scientific information have dramatically changed and are being up-graded constantly. There is less "re-inventing the wheel" at our laboratory through improved search capabilities. We feel this is one way to make our scientists more effective and productive. (49)

Increased volume requirements, including need for increased awareness of overseas and international scientific literature. (50)

Yes, it must be consolidated to be utilized - also faster. Should use electronic communication. (51)

B. IS MANAGEMENT WILLING TO SUPPLY MORE AND BETTER INFORMATION SOURCES FOR YOUR EMPLOYEES? HAS YOUR COMPANY SHIFTED TO ELECTRONIC INFORMATION SERVICES FROM PRINTED INFORMATION? IF SO, TO WHAT EXTENT?

Management is willing and we are moving towards eletronic information services, but are not there yet. (1)

Our company is exploring electronic information services. We need more information to bring it online. A workshop addressing ACS operations would be most helpful. (2)

Heavy shift to electronic services accessed by individuals. R&D personnel are expensive so it wise to supply more and better information rapidly. (3)

Personal Computers (4)

Yes. (5)

Yes. Yes, to a greater extent. (6)

Yes. The shift is steady & not expected to slow down. (7)

Management remains in a curtailment mode. In addition to reducing staff, literature and library space is being continually reduced. (8)

Yes. Yes. It has doubled since 1982. (9)

Yes. Electronic mail is growing and will soon be used for library as well as internal information. (10)

Several new channels between management and employees (both directions) have been implemented within the past 2-3 years. These include printed, personal, and electronic methods. As one example, various company directors address the employees regularly on the company and its future directions. As a second example, news releases by the company (on the day of release) are sent by computer distribution to many employees throughout the company's many divisions. (11)

Yes. Yes. There is no longer a card catalog (for example) in our library (12)

We use both printed and electronic information. (13)

Yes. Yes. (14)

Yes (15)

Yes. Yes. - (16)

Strong support from Management to acquire necessary equipment and information resources. We have shifted from printed to electronic medium for searching, i.e., a) have contracts with 12 online vendors which gives us access to 1,200 databases, b) sponsored in-house DIALOG seminars (80 scientists and project leaders trained in online searching), and c) converting index of proprietary information from card catalog to online database. (17)

Yes. Yes, partially - more scientists & engineers are using electron systems personal computers etc.) but some still like the hard copy aspects of paper. (18)

Yes. Yes. Low 50-50 (19)

Yes, We have just bought the MDL package of MACCS and REACCS. We are also equipping our labs with personal computers (MAC's) which tie into CA searching. (20)

Yes. Yes; to a large extent. (21)

Yes, about 50%. (22)

Absolutely. No more library stacks two years from now. New facilities will have reading rooms for journals etc. with some reference material. Literature searching is now all electronic. (23)

We are in process of switching over to electronic information searching. We do continue to maintain various printed journals as well in library. (24)

Make use of various databases, such as Chemical Abstracts, Lockheed. (25)

Yes, not completely electronic (26)

We now spend $250,000 per year on electronic information retrieval versus $600,000 for journals and $70,000 for books. (27)

Yes, to some extent, however, nothing seems to be able to replace paper. (28)

Willing, but not necessarily able, more reliance on academic information resources. Yes, particularly computer information retrieval and literature search. (29)

Yes, management is willing. The shift to electronic information is in progress. Electronic "on line searches are common". Hard copies of Chemical Abstracts are seldom used. Hard copies of most technical reports are still used. (30)

Yes, shifting for publication to more search services. (31)

Yes
Yes (32)

Yes, we do a lot with data bases and minimize printed sources. (33)

It is up to us to determine what we require. The shift is towards Electronic information services. Don't see where printed information significantly reduced. (34)

We continually upgrade our information sources at no small cost. It is more than justified based on the information provided company-wide, not just for internal purposes. We are heavily into electronic information services. (35)

Shift to electronic information use just beginning in the office. (36)

Yes. Yes. (37)

Yes. Yes. The library is fully automated and services are available to all, over the Department's local area network (LAN). In fact our libary automation software is rapidly becoming an industry standard. Many paper reports are now available only via the LAN. (38)

Yes, management supplies adequate information sources. Yes, to electronic information, DASYS for literature. (39)

See III-C. (40)

Yes, much emphasis on electronically available information. (41)

Generally, yes to a small extent. We have shifted to electronic information; all searches are electronic; journals still are not. (42)

CAS On-Line now used. (43)

Yes, we now subscribe to various on-line search capabilities. Card files are now computerized (44)

We believe quality information is the prerequisite of quality R&D. In the last several years we have appropriated significant resources to completely computerize our information services. (45)

Yes, better sources are available. (46)

Yes - see above. (47)

Good information sources are a must. We have our own "Research Information Center and Library" and subscribe to Lockheed's "DIALOG" Electronic Information Service. (48)

Yes, as long as it is considered to be cost effective, and the shift has occurred within our laboratory. We have created a variety of computerized databanks covering a number of areas applied to our

packaging research and development applications which we feel are the best in the packaging industry. They are readily accessible and have paid for themselves time after time. Wei also use all the on-line databanks that apply to our business and R&D efforts. (49)

Believe that better information sources are the lifeline of new discovery efforts. Full commitment to electronic information services has been made. (50)

Yes, sure, but more and faster are needed. (51)

C. DO YOU PERCEIVE YOUR NEEDS ARE CHANGING FOR INFORMATION ON INTERNATIONAL SCIENTIFIC DEVELOPMENTS? IF SO, HOW IS YOUR ORGANIZATION ADDRESSING THESE REQUIREMENTS?

Yes - but we have not addressed this yet (1)

With the shift of technologies to other countries, the ability to access international development becomes more important. In general, members of our company are spending more time in foreign countries acquiring "first hand" technical information. (2)

There is a definite trend towards "internationalizing" of R&D. It's as important to know what's happening across the world as across the hall. Our people are attending international meetings and visiting foreign subsidiaries and universities. (3)

I do not know. (4)

No. (5)

Our company is international & our parent has one of the largest industrial libraries in the world. We are well taken care of when in need of information on international developments. (7)

Yes, I believe we need greater access to international publications. Our organization does not appear to be addressing this problem. (8)

Yes. We are a multinational corporation and have our own cross fertilization of technical information. (9)

Yes. More use of commercial databases (10)

The best way to illustrate the importance of this subject is by action. Our company has recently established a research and development effort in Japan, in order to participate more directly in the scientific and technical climate there. Parallel efforts in other, business-related areas also have increased staff in Japan. This effort is in addition to the world-wide R&D effort that has existed for decades in three other locations: England, France, Australia. (11)

No comment. (12)

- (13)

Needs for state-of the-art technology has always been a priority. (14)

Yes. (15)

Yes. - (16)

We have excellent contacts with the international scientific community. (More in Section VI.) International scientific developments are followed by: a) increasing subscription to European and Japanese periodicals, newsletters, b) providing excellent language services support, c) accessing international online databases, and d) inviting internationally acclaimed experts to in-house seminars. (17)

Awareness & broad reading is necessary. Electronic databases are useful. (18)

Databases are increasing is their incorporation of this material. (19)

Yes. We see more significant work coming out of Japan. We have not gone beyond having more translations done. (20)

For quite some time; the pharmaceutical industry has required information on international scientific developments. This need will only increase in the future. We are equipped for this. (21)

We have always covered the developments worldwide and have taken advantage of computerized patent searches and literature searches. (22)

Yes. We are generally building up our R&D facilities in areas where economics are growing. Principally in SE Asia Strategy is to be where action is. (23)

I think information avail is already pretty much on an international scale. (24)

Increasing use of outside consulting firms for greater coverage of international developments. (25)

We need and are getting international information. Overseas partners and operation, expanded library, etc. addresses this. (26)

We have an active Japanese information program ongoing with Japanese consultants. (27)

We are a world-wide company and receive information from all parts of the globe. (28)

Yes. More information is available and needed. With difficulty. (29)

No, we are an internationally based oil company, and as such, always have had to be aware of technology developments worldwide.

No. (31)

- (32)

We monitor some developments off-shore in key areas - but almost all published data is reference only not really current-helps to know trends. (33)

We have people within the company who are supposed to keep abreast of scientific developments. (34)

Increased data base access. (35)

Relying on ability of computer databases and specific periodicals to cover that area. (36)

Yes. (37)

Yes, we are using more non-domestic sources, both electronic and printed to meet our scientific information needs. (38)

Most international journals publish good science from any country. (39)

No change. (40)

No. (41)

No great change expected. (42)

Yes. New position to survey international development. (43)

Always had these requirements. The only limit has been budget restrictions on subscribing to some foreign journals. (44)

There is an increasing need for scientific development information from the Pacific region. We are addressing these requirements by (1) retaining an overseas consulting firm, (2) setting up an overseas technical liaison office, and (3) establishing an R&D center abroad. (45)

Needs are not changing - they were always there but sources are now more readily available and timely. (46)

We have adjusted our efforts to focus on what is going on worldwide, not just in the U.S. or North America. (47)

We have engaged in cooperative research efforts with companies in Germany and Japan, among others, and have been privy to information through these sources. We will probably need more information on international scientific developments at the basic research level, than in the past. Our information is gained through published papers and association with foreign companies. (48)

Yes, as the largest packaging company in the world, the international scientific scene is very important to us. We not only subscribe to publications that deal with this area, but have on-line computer data search capabilities to further address our international scientific information needs. (49)

We have always been committed to remaining abreast of international scientific developments. (50)

It has always been international for us! (51)

## IV. MANPOWER

A. HOW DO YOU SEE YOUR ORGANIZATION'S REQUIREMENTS FOR TECHNICAL PERSONNEL CHANGING IN THE NEXT SEVERAL YEARS? PLEASE INDICATE ANY SHIFTS IN NUMBER AND DISTRIBUTION BY DEGREE (E.G. TECHNICIANS, BS, MS, Ph.D.).

We will increase (i.e., plan to increase) staff 25% by 1990, primarily by adding Ph.D. level people & technicians (AAS/BS) (1)

The shift will be directed toward Ph.D. level individuals who can communicate and operate in the interdisciplinary areas such as bio-processing, materials technology, etc. (2)

More Ph.D.'s compared to BS/MS. More scientists compared to engineers. Higher ratio of life scientists to chemists. Our chemists and life scientists are all Ph.D.'s. The majority of BS/MS people we hire are chemical engineers. (3)

More technicians and contract people (4)

Not much change expected. (5)

Static for the next several years. (6)

I don't see any drastic shifts. We will still hire heavily at the Ph.D. level for chemists & at the M.S./Ph.D. levels for chemical engineers. The total number changes but the distribution stays rather constant. (7)

An increase in technicians will certainly be required to support the efforts of our remaining core of professionals. (8)

Changing and asking for more Ph.D.'s and higher qualifications. (9)

More Ph.D.'s and technicians. Less B.S. scientists (10)

Research and Development in new areas may require a different ratio of "highly-trained to support" personnel. As these areas become a larger fraction of our activities, our technical personnel requirements will definitely shift. For example, the bioscience area requires a more equal ratio of support personnel to highly trained personnel than we currently employ. (11)

Oil business is in a slump. Hiring requirements will be small. Distribution not expected to change. (12)

As indicated above, we are shrinking in all levels of educational background. (13)

No shifts in ratio. Number up. (14)

Modest change to higher degrees. (15)

Probably an increase in the ratio of Ph.D. to BS-MS. The total number will remain unchanged (16)

Number will increase. Concentration for new employees will be PhD's in emerging technologies, currently, ratio of PhD to professional total (BS + MS + PhD) is about 0.55/1.00. That will likely increase. Technician ratio of 1.7 to 1.0 professional will not likely change dramatically for us. (17)

About the same - is a mixture of all four catagories cited. (18)

More BS & MS & less technicians. (19)

We need more scientists, especially analytical chemists, organic synthesis and process research chemists. Our mix is not changing, but the focus on "head count" means more of the new hires will be at the Ph.D. level. (20)

Yes, increasing - the greatest increase at the higher degree levels. (21)

We have always required a good percentage of Ph.D. chemists, but someone still has to do the laboratory experiments. I see our organization expanding but the ratio of Ph.D. to MS/BS will remain about the same which is one to one. (22)

Seems like we are moving to increases in technicians and Ph.D.s at the expnse of BS, MS. Particularly in engineering/chemistry. (23)

At present, we don't see a shift in distribution. We will be needing more of all levels. (24)

No change. We normally recruit only at the Ph.D. level. (25)

No. (26)

No change. (27)

A few years ago we had a rapid growth which has now plateaued. Our need for new people over the next few years will be modest. (28)

More M.S. Ph.D. specialty areas of polymer science. (29)

For the next 2 to 3 years, the manpower levels are likely to remain constant. After that there is likely to be an increase in the need for technical personnel. Because of very limited hiring in recent years, the average age of R&D personnel has increased. Young technical personnel will have to be hired at some point to maintain the integrity of the R&D entity. Probably the percentage of Ph.D.'s will increase. (30)

Stable 3-5 years. (31)

Not a lot of change but a major change in what we want our new hires to know. Increased flexibility, ability to adapt their science in widely varying environments. In engineering for example the era of super optimization is over. Flexible plants, and yes, even batch plants are back in vogue. Even as long ago as the late 50's, batch was a bad word. (32)

We've recently restructured, and are now seeking technical people, we'll probably grow. Ph.D. (M.S.) number will be small, they will be very good and very versatile, more BSs at tech expense. (33)

I foresee no basic shift. Tendency is to hire people with Ph.D. degree. (34)

Only two subtle changes: 1. Hire more M.S. engineering graduates (versus B.S.). 2. Ph.D. graduates with specialized skills (environmental microbiology). Overall hiring to remain flat. (35)

Anticipate growth in R&D staff, limited Ph.D. openings and more BS/MS personnel. (36)

Little change compared to recent slice of history. (37)

Since our industry is a "mature" one, there will not be any drastic changes in number, however, degree distribution will probably shift downwards and hiring will be in areas where specialized expertise is needed. The downward shift in degree distribution will occur as younger scientists replace older scientists who are reaching retirement eligibility. (38)

Chemists increasing slightly, more biochemists, retain the 1:1 ratio of BS and Ph.D., or slight increase in number of Ph.D.'s. (39)

No shift. (40)

Basically the same. (41)

Need for technical personnel increasing; no change in distribution. (42)

Approximately constant, but shifts as II D. (43)

We will continue to recruit in a limited way to replace people lost through attrition and to meet specific needs. (44)

We will see an increasng ratio of professionals versus technicians due to the progress of laboratory automation. (45)

Little change in the foreseeable future. (46)

We expect to continue to hire 10 to 15 college-degreed people/year with the major emphasis being B.S. and M.S. level people (47)

We are currently at a low point in numbers of technical personnel and anticipate a slow but steady growth over the next several years as business develops in new areas such as municipal solid waste plants, and picks up in our traditional market--steam generating and petroleum refining equipment and engineerng services. (48)

There is need for better qualified and better trained personnel in the materials science field. Since we are at the forefront of the materials aspects of packaging, we require technical personnel who can further advance our leading-edge capabilities. A most neglected area of training is in the field of report and project writing. The obvious neglect of training in this basic area is even more obvious in the recent graduates. (49)

No significant change; will continue to hire at historic rates. (50)

More towards Ph.D., and more of them. (51)

B. DO YOU EXPERIENCE, OR DO YOU EXPECT TO EXPERIENCE DIFFICULTIES IN RECRUITING U.S. CITIZENS FOR YOUR ORGANIZATION?

Not really - although we do obtain resumes from a large number of non-U.S. citizens (1)

No! 1) We are restricted to U.S. citizens. 2) We are very cautious and methodical in our recruiting practices such that approximately 75% of the offers made are accepted. (2)

Yes. Absolute numbers and percentages for U.S. citizens decreasing at Ph.D. level. U.S. citizens seem to be opting out of Ph.D.'s in chemistry and life sciences. (3)

Yes (4)

No. (5)

No. (6)

No. (7)

Yes. Difficulties in recruiting U.S. citizens occur because of "Equal Employment Opportunity Act" requirements. (8)

Difficulties in recruiting U.S. personnel and in recruiting worldwide. (9)

Yes, because of the high cost of living in the northeast. (10)

No, difficulties are not expected. (11)

No. (12)

No. (13)

No. (14)

Yes, particularly at high degree levels. (15)

No. (16)

No. In emerging technologies (expert systems, ceramics, composite structures, etc.) there are not enough PhD's to go around, but there are also no foreigners available either. On balance, we can hire the U.S. people we need. (17)

To some extent. Particularly with regard to minorities who are just not available. (18)

No. (19)

No. (20)

No. (21)

Generally, no. (22)

Not really. (23)

No. (24)

No. (25)

Yes - more foreign Ph.D.s and Post Doctorals in needed disciplines. (26)

No. (27)

We seem to interview and, in fact, hire a disproportionate number of non-U.S. citizens. The number of qualified U.S. citizen candidates seems to be decreasing. (28)

Yes definitely. Graduate schools are less willing to train American students and invest in local students. Strongly suspect universities want low cost foreign graduate students to further individual academic research careers of faculty members. (29)

Overall no. In seeking technical personnel with specialized skills, we have had few difficulties. (30)

U.S. citizen applications seem to be a minority. (31)

Not really. (32)

Flow of candidates at the Doctoral level is heavy slanted to foreign nationals. Probably reflects grad school enrollments. We have hired successfully without regard to origin. (33)

Yes, in some areas. (34)

No. (35)

No - it is not on up-front issue. (36)

Yes, particularly materials science. (37)

No. (38)

No. (39)

No. (40)

No. (41)

No. (42)

Non-U.S. citizens are always a high percentage of job applicants. (43)

No. (44)

We have not had difficulties in recruiting U.S. citizens. (45)

No difficulties are anticipated in most fields. Ph.D. analytical chemists may continue to be difficult to recruit. (46)

No. (47)

There does seem to be a preponderence of foreign born applicants for technical positions, many of whom are not yet citizens. This might present problems when dealing with contracts which require security clearances. (48)

Yes, particularly in all the areas related to the various materials sciences. (49)

No difficulties anticipated. (50)

? (51)

C. HOW DOES YOUR ORGANIZATION TAP INTO THE SUBSTANTIAL EXPERIENCE AND KNOWLEDGE AVAILABLE IN THE GROWING RESERVOIR OF RETIRED CHEMISTS?

Primarily as consultants. (1)

Our company has not pursued this arena. (2)

Not at all. (3)

Use company retirees. (4)

Not much, except for use of some consultants who may be "retired". (5)

Don't! (6)

We do not tap this source at present. (7)

These individuals are employed on a part-time basis as consultants. Unfortunately, these services act only as quick-fixes to diverse technical problems. (8)

We don't. (9)

We currently utilize our own retired chemists as consultants. (10)

Retired chemists (and others) are consultants for our company. Both traditional business areas and new business areas use them. (11)

Hire them as consultants on occasion. (12)

We don't. (13)

Consultants. (15)

Not at all to my knowledge. (16)

Except to use them as a paid, but not fully utilized, consultant, we have no plans. (17)

Not significantly. (18)

Use as consultants. (19)

We use a few as consultants on occasion. By most standards, we do not use retired chemists adequately. (20)

Some are retired on a part-time basis. (21)

We have kept on specialists and exceptional individuals as consultants; some of them older than 70. (22)

We employ consultants widely but not particularly in chemistry. Most retired chemists are employable for their judgement. They usually are technically obsolete - like me. (23)

We are just starting to evaluate this pool through a local university/industry pooling service. (24)

Use retirees as consultants as needed. (25)

Not very well. (26)

Use retired employees as consultants. (27)

We do not to any great extent. (28)

It doesn't. (29)

Not at all. (30)

We don't. (31)

Old boy network - need some good directories. ACS could do a real service here. An opportunity to couple retired chemists and x's lab space. (32)

We utilize as consultants, or part-timers. They enjoy the opportunities. A lot of our own retirees. (33)

To my knowledge, there is little contact with retired chemists. (34)

We use retired chemical scientists extensively for consulting, special assignments, and for peak workloads. (35)

We do not, to my knowledge. (36)

We do not. (37)

We retain many of our retired scientists as consultants. (38)

Not yet. (39)

- (40)

No. (41)

Through the chain of consultants; but no organized programs. (42)

Retired chemists sometimes retained as consultants and for work on special projects. (43)

Doesn't as far as I know. (44)

Many of our retired chemists continue to work for us on a consulting basis. We are also using more outside consultants, many of whom are retired chemists. (45)

We have no experience in this area except in rehiring retired employees of our company as part-time consultants or fill-in laboratory chemists. (46)

We retain these people as consultants in areas of specialization. (47)

We do hire retired chemical personnel on a consulting basis, for specific needs associated with our business. Many of these people are our retired personnel. (48)

We do use them on an "as-needed" basis for hands-on work to supplement our own staff in times of priority scheduling. We have also brought them in as consultants for training of personnel in their particular areas of expertise when required. (49)

Occasionally, we seek administrative support to maintain continuity. (50)

We don't. (51)

D. LOOKING FIVE YEARS OUT, WILL YOU BE SPENDING MORE, LESS, OR THE SAME ON R&D EITHER IN DOLLARS OR PERCENTAGE TERMS?

More (according to our 5-year plan) (1)

Our projections indicate we will double the chemistry R&D budget? (2)

More in real dollars. (3)

Same percentage (4)

Probably about the same. (5)

Same (6)

Perhaps a little more in % (7)

If we are to regain our industrial vitality, our R&D efforts must be supported with greater spending. Stockholders and corporate management must develop a need to look past next months earnings. (8)

More (9)

About the same. (10)

Total R&D spending will grow moderately in dollar terms. Both the degree and type of growth will vary from one business area to another. Research in new areas will grow rapidly, whereas in traditional areas development will also have continued emphasis. (11)

Same in $. (12)

Don't know. (13)

More (14)

Slightly more. (15)

More in dollars, probably less in percentage (16)

To survive in a higher-tech world, we'll have to spend more--not less. (17)

About the same in percentage terms. (18)

Same percent (19)

More. (20)

Spending more in dollars and percentage. (21)

More in both. (22)

We would anticipate doubling R&D every five years in current dollars. This has been our normal rate. (23)

More as % of sales. (24)

More dollars, same %. (25)

Probably the same in %. (26)

Same. (27)

More. (28)

Less percentage. (29)

In percentage terms, there is likely to be an increase. (30)

More - maybe 10%. (31)

In % terms same to slightly more. (32)

Estimate the same with some increases after restructuring earlier. (33)

Expect to spend the same or more. (34)

More; the company is in a growth mode, both via acquisition and internal development. I would anticipate 20-30 percent more R&D within 5 years. (35)

Aim is to spend slightly more at % of sales, in my opinion. (36)

More. (37)

I expect our R&D budget to increase in dollars only to the extent that inflation increases it, except in special areas of "hot" research. (38)

Slightly more in %, significantly more in $. (39)

More in dollars & percentage. (40)

Same. (41)

Probably more $ for R&D, as % of sales. (42)

Probably similar. (43)

Slightly less in inflation corrected $. (44)

We will be spending more on R&D, in both dollars and percentage terms, during the next five years. (45)

We will probably continue R&D spending at about the same level in terms of percentage of sales or income. (46)

About the same. (47)

We anticipate spending more in dollars on R&D in the years ahead. This is contingent upon the business climate improving over these same years. (48)

On a percentage basis, we would expect the R&D expenditure to be approximately at the same level. However, there are always shifts among the type of disciplines and technologies depending on the nature of the projected R&D efforts. (49)

Continued expansion of R&D operations anticipated. (50)

More in %, in my opinion. (51)

## V. PUBLIC IMAGE

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A. DO YOU PERCEIVE ANY CHANGES OR DETERIORATION IN THE PUBLIC'S PERCEPTION AND UNDERSTANDING OF YOUR COMPANY'S OPERATION? MOREOVER, DO YOU SEE THIS CHANGE IN PUBLIC OPINION OCCURING IN THE LOCAL, REGIONAL, OR NATIONAL LEVEL?

---

I believe that there is an improved public image in the two years I've been at the company (1)

Our management and the USDOE are very sensitive to public image. A change in this attitude is not anticipated. (2)

As R&D gets more complex, the public has a more difficult time understanding our operation. Public image of chemistry is poor and suspect. We see this at local, regional, and national levels. Witness the Bhopal fiasco. (3)

Improvement local (4)

There is and has been for years a gradual unfavorable change in public perception of the chemical and allied industries. (5)

Yes, at all levels because of the major cut in R&D due to restructuring of the company. (6)

We are on an upswing now in public understanding & recognition of our company. I'd hate to think about any deterioration. (7)

Public opinion of American scientific efforts will continue to deteriorate until cures for cancer, AIDS, etc., are discovered by researchers. A reversal of this trend could occur with a new, successful scientific program. (8)

Absolutely not (9)

No. Still have a good image (10)

Yes. Certain cost-cutting activities like workforce reductions by the company have had high publicity locally. New business partnerships have been well publicized locally/nationally. Mr. Chandler (CEO) is active nationally to emphasize the effects of US dollar exchange rate and the US deficit on our multinational business effectiveness. A national awareness of what makes the US competitive is needed. (11)

Environmental issues have always been a problem in recent years. I see no big changes for the future. (12)

We are not a chemical enterprise (13)

No (14)

Improvement (15)

Short term deterioration (national and international) due to layoff (2/4/85) and environmental problems (16)

No change seen. High tech companies seem to be held in respect by society, so as we move to high-tech output, we should see an increasing positive image of ourselves in the public's mind's eye. This improvement should be national to be effective. (17)

No, not now that we have gotten the worst of the environmental movement behind us. We are regarded as behaving responsibly. (18)

Largely unchanged at all levels (19)

Our perception as a benign industry is being attacked by Greenpeace which believes we are contributing to the pollution problem. (This is at the local level.) (20)

Yes - deterioration at all levels. (21)

I think the image of the science has been greatly improved. If there is any good coming out of the AIDS epidemic, it is a positive picture of the sciences in general. (22)

No, we have a good image where we have R&D or manufacturing locations. Otherwise no one has ever heard of us. We do everything possible not to have a bad safety or ecological incident. We even pray. (23)

While market is national and international, our public perception is pretty much local. We have worked very hard to improve our local image and have been quite successful. (24)

Public perception of our operation is gradually deteriorating on all levels, due to adverse publicity associated with: a) EPA regulations to dumpsites; b) Nader attacks on the use of agricultural chemicals. (25)

No change. (26)

We have a large PR campaign called Community Chemistry with the theme "People Practicing Good Chemistry". I see improvement in our public image. (27)

No. We are a consumer company with an excellent public perception. (28)

Less appreciation for technical advances and new and better products and more of a "taken for granted" attitude. More national media and about the same for local and regional. (29)

On a national level, a change is unlikely. On a regional or local level, where employment is impacted by company profits - yes. When more money is spent on exploration and producing again, it will be appreciated more - and not just accepted and "expected." As the price of oil increases, resistance to offshore drilling, and drilling on public land, may decrease. (30)

Locally - great improvement. (31)

Yes, & all - chem as a profession & the industry have a massive image problem. Industry is working hard on it, but until layman knowledge is increased. The profession will remain terrifying to people at large. (32)

Chemistry is not, in general, held in high esteem at the primary & secondary levels in education. Chemistry teachers consider themselves science tea in many cases. The public, in general, hasn't been exposed to any understanding of chemistry since college or high school, 20-30 years ago. They consider HCl as toxic as phosgene, sulfuric acid as toxic as methyl isocyanate. Hard to explain any chemical company's operation anywhere. (33)

Expect little to no change. (34)

The effects of Love Canal negative publicity have been long-lived. It is difficult to focus public attention away from that situation and toward the positive contributions of the company. (35)

Any changes in perception are, I believe, positive as company grows and new products are made available. (36)

Yes, because of Bhopal & our response to it. (37)

The public acceptance of science and scientists has decreased. Opinion polls show this phenomena. In our particular industry, we face increasing governmental restricutions in our legitimate business operations as well as over-zealous opponents basing decisions on inadequate and/or inaccurate data. These changes are at all levels. (38)

We have significantly improved our image as a major scientific innovator. (39)

I do not see the public view of chemistry or chemical plants changing dramatically unless there is a substantical increase in public education. (40)

No change perceived. (41)

I expect no change in public opinion. I believe the informed segment of the public recognizes and understands the chemical company's operations. (42)

Yes, at all levels. (43)

Perception of company's product has drastically improved. (44)

There is a general deterioration in the public's perception of the overall chemical industry. This is occurring on a worldwide level. (45)

No change in the specific perception of the company except in a generic way - the words chemical and chemistry have become increasingly associated with toxic and toxicity in the public view. (46)

No. (47)

We have been historically recognized as an engineer contractor for the process industries and as a manufacturer of equipment for steam generation for utilities and industrial companies. In these areas, we have always been recognized as one of the leaders. Because of the steep decline in this area of business over the last five years, new areas of activity for us includes ownership and operation of resource recovery and cogeneration plants and real estate development. Because these type activities have a long development time, the public may not be aware of the expanded scope of the company operations. (48)

No. (49)

Foresee a tougher period of scrutiny in general. We perceive an improvement in public perception of our research and management. (50)

Not a problem for us, but it sure is for many others. (51)

B. PLEASE COMMENT ON THE ROLE OF THE MEDIA, CONGRESS, FEDERAL/STATE GOVERNMENTS, FEDERAL AGENCIES, AND OTHER INSTITUTIONS REGARDING THE PUBLIC IMAGE OF THE CHEMICAL ENTERPRISE?

? (1)

We're not doing enough to build a public image. The press has highlighted the negatives and failed to balance with positive accomplishments. The poor public image is at least partially responsible for fewer young people pursuing science careers. (3)

Too complex (4)

Undoubtedly, the media exacerbates any accidents or the like in the public perception. (5)

All these parties have a major impact but chemical industry has not taken an aggressive enough stand to educate public about the benefits & role of chemistry in society. (6)

Obviously, all of the institutions named above can play a very important role in shaping public opinion. (7)

A winner is needed to overshadow our shortcomings, e.g. atmospheric destruction, waste management (8)

Regulatory bodies are behind the times. Media has made a bad situation based on a few for many. Media has made chemistry a dirty word. (9)

- (10)

Improved understanding in government can lead to more rational decision-making about health and environmental issues, but policy makers do not have sufficient technical support to allow this to improve. Media reports should be accurate and placed in a rational perspective, but again resources for this may be scarce. (11)

No comment (12)

We are not a chemical enterprise. (13)

No comment. (14)

Very important (15)

The media have nearly absolute control by virtue of their ability to distort or misunderstand the truth. It is through the media that Congress, etc. speak. Unfortunately, the chemical industry probably deserves the negative image created by the media. (16)

All of these institutions seem to accent the negative side of our industry. Media and Congress are key because the media can report what they believe are facts without total regard to accuracy, and of course, Congress holds the legislative keys to our economic well-being as they pass laws regulating taxes, the environment, and fair trade. On balance, the less involvement these groups have in our business, the better our image will be. (17)

Generally unbalanced & not objective. Therefore public image is poor. Worse for chemical companies than for pulp & paper companies (18)

All leave much to be desired, but improvements are not readily available (19)

The chemical industry is suffering from the sins of the past and not so far past. We, who use chemicals are easy targets for the media and our elected officials. A campaign to publicize the positive values of chemistry is long overdue. Our local section (Northeastern Section) is sponsoring a new award to publicize the positive aspects, "The Gustavius John Esselin Award for Chemistry in the Public Interest." More work by ACS, national, and local sections, is in order. (20)

I believe any changes in image will be primarily the result of industrial initiatives and activities. (21)

In general, the media thrives on negative aspects particularly 20/20, Sixty Minutes, and the like. The federal and state agencies for the most part are performing a watchdog function ; e.g., FDA, EPA, OSHA, etc. If anything, they convey a negative image, merely because their function is restricted to correct a wrong. (22)

I have nothing good to say about them. Chemophobia dominates these segments. (23)

The chemical industry has obviously been getting a lot of bad press. Some may be justified but there is a lot of ignorance and misinformation stressing emotion rather than logic from the media. This applies to local, regional, and national. Likewise, the Congress tends to apply politics rather than logic. (24)

The media always emphasizes the negative aspects, and rarely presents the more positive apsects of the chemical enterprise. (25)

You've got to be kidding - you know what it is. (26)

- (27)

The media has an enormous effect on the public's impression of chemistry. It is mostly, but not totally negative. The chemical industry is its own worst enemy. The recent Sandoz fire in Basel followed by a large amount of cover-up dumping is an example. (28)

Media obsession with sensationalism. One positive note is public or educational TV. Congress politically hamstrung and pandering to media. Federal agencies inability to regulate without excessive disruption and cost due to entrenched bureaucratic and politically bound system. (30)

Local & state very supportive. (31)

Ignorance, cheap shots, & an elitism by the profession so that there truely has never been an effective chemistry for non chemists. (32)

It's very hard to get a balanced or a good understanding of the risks, dangers etc. involved with chemicals. No one ever mentions the good use & products. As stated above, the absence of general understanding, makes sensationalism, fear, etc., very real situations. The media doesn't present much of the good industry does. The past hasn't been perfect and now reason is tough to establish. (33)

No comment. (34)

In my opinion, the media rarely provides a balanced view of the chemical industry's contributions to society. The positive "news" doesn't sell newspapers. Unfortunately, the general population doesn't want to be educated, except by headlines. This is a most difficult situation to overcome. However, it is primarily the responsibility of industry to tackle this uphill fight. (35)

PR efforts of individual companies and institutions such as ACS on probably most important factors (36)

Overall, promote a negative public image. (37)

Other than organizations representing professional and/or technical societies, the above-mentioned groups, institutions, etc., tend to be neutral to negative in their public commentaries on anything relating to the chemical sector. We are easy to "bash." (38)

The media has hyped biotechnology and related sciences to the detriment of credibility, but it has caused reporters and industry to do a better job of reporting important scientific accomplishments. Congress and government agencies have put so much emphasis on AIDS, that they have demonstrated the impact of government priority not seen since the peak of space exploration. The general image of chemists is, however, much lower now then in the 50's and 60's. (39)

Most publicity has been negative. (40)

The chemical industry is under closer scrutiny from the public, which means there is a need for greater awareness for these people of our efforts. (41)

I believe science continually is in the public eye. And the natural toxicity of "chemicals" is being recognized. I believe that the question being asked is, "How can we properly handle chemicals?" not, "How should we shut down the industry?" (42)

Media negative. (43)

No comment. (44)

Too much emphasis has been placed on the hazards of chemicals, often without prudent scientific evidence. There is not enough awareness of the contribution of the chemical industry to the welfare of the society. (45)

Because of general misunderstanding of chemistry and science, individuals in all of the organizations listed in the question have continually distorted reality and have adversely affected the public image. On the other hand the few blatant examples of chemical enterprise violating the public trust have also contributed disproportionately to the making of the current image. (46)

Chemicals have a tarnished image which private industry, government and and other institutions need to represent more objectively. (47)

The public image of the chemical enterprise has suffered in recent years as awareness of toxic and hazardous waste and the environmental dangers resulting therefrom are spotlighted by the media. While some of the criticism may be justified, the media and others have focussed on the problems and have generally not given adequate coverage to the progress in alleviating the problem. (48)

It is self-evident that the "chemical emterprise" has been the recipient of many a "black eye" from the aforementioned institutions. The chemical enterprise has been derelict and reluctant to take the initiative to spell out to the public the contributions they have made to improve the quality of life and well-being of U.S. citizens. They also need to take a positive and prompt approach toward solving the problems which come to light as scientific knowledge and analytical capabilities increase. All of which could do much to improve its public image. (49)

This is a very dynamic interaction, and all these organizations have a profound impact on the chemical industry. The media and federal agencies are becoming more involved. (50)

Obviously very important. (51)

C. WHAT IS YOUR COMPANY DOING TO RESPOND TO THESE CHALLENGES? HAS YOUR ORGANIZATION INITIATED NEW PROGRAMS OR INCREASED EMPHASIS ON ACTIVITIES TO ENHANCE PUBLIC UNDERSTANDING OF SCIENCE?

Our response has been defensive rather than offensive (1)

Yes, through technology transfer and public science awareness functions. (2)

We provide technical and career talks, donate equipment to schools, support science fairs with money and personnel, give R&D lab tours to high school and college groups. (3)

Initiated "Chemical Facts of Life." No support from other chemical companies Now developing a "total quality" approach. (4)

There have been programs to improve the company's performance in several areas of societal concern. Additional instruction, training & communications have been ongoing for several years. (5)

No. (6)

We have an office of public advocacy which is active in Washington, in the community & within the company (7)

No. (8)

We have our own internal policies and a new marketing director. (9)

- (10)

It is my opinion that we are responsible and forthright in providing both action and information to the public about company activities. I think the public perception of us is similar. In addition, I think internal procedures are well attended to. In the chemical industry in general, these two items are very important and need to be at a level that enhances public confidence in industry. With public understanding, three areas come to mind: 1) economic impact of fiscal policy (US dollar; deficit); 2) increased highlighting of company science/technology to each of our employees (through widely circulated company newspaper; 3) expanded support for raising quality in public education [see attached article, 3/12/87]. (11)

We have always supported educational programs extensively but we can't see any increase for the future. (12)

- (13)

What challenges? (14)

More outward education and communication (15)

We make every possible effort to be good citizens and dedicate our productivity to the benefit of the public (16)

We've done nothing on a national scale to maintain contact with our congressional reps. Statewide, we do little that is broadly circulated. Locally, we do things like Junior Achievement, Explorers' Posts, and public relations releases. (17)

Yes, to some extent. (18)

Yes, but its more of the same. (19)

We are awakening to our position as a "polluter," but have done little more than initiate the engineering work to control emissions. The local ACS section has asked our company for help in promoting the positive aspects of chemistry but no decision has been made. (20)

Full compliance with the law. Occasional interaction with civic groups, adopt-a-school programs, seminars at schools and colleges, support of PMA activities. (21)

Not really by words. Although we have improved our image by deeds. Treatments for AIDS, hepatitis, stroke, Alzheimers disease, and the like, are bound to have a positive effect on the public. (22)

We likely have done too little. Our company has pointed its public efforts to improving the miserable performance of our U.S. educational systems. (23)

As stated earlier, we have spent a lot of time and effort to improve our local image and capabilities. We have attempted to become the most attractive industry in our area. We have also funded local educational exhibits and provided articles to the press. (24)

We keep our home in order and have our people respond to their community's need for information. We are very active in several CMA programs. Our people talk at high schools and colleges, and are available for media interviews. (26)

See A. (27)

No. (28)

Don't know of any other than working through trade associations - efforts now well published. (29)

We try to maintain and improve our industry/company image by directly contacting legislators, and by participation in industry organizations which pursue our interests collectively with others. Whenever possible, the company's positions are made as part of presentations to schools and

community groups. The public media does not appreciate technical problems and is unsympathetic in their writing about complex problems. (30)

Nothing formal. (31)

CAER. Local avtivities open houses community emergency drills. (32)

We are involved in community relations programs, and stress communications. (33)

No. (34)

Community awareness programs. Plant and laboratory open houses. Community relations programs. Science fairs. Chemistry lecturers. (35)

Company supports appropriate local scientific institutions as well as community functions (36)

Aggressive program to promote both company and industry. (37)

The company has undertaken a firm stance on our position of our legal right to conduct our business with the publication of a monthly magazine. We frequently fund programs in the arts and education. No, we have not been as active in the area of public understanding of science. (38)

Only an increased effort to related significant scientific accomplishments to the general public. Much of the motivation for increased public awareness belongs to financial analysts and the stock market. Financial rewards are now sought in addition to scientific recognition. (39)

Support organizations such as PMA & ACS Corporate Association. (40)

Programs have been initiated to educate and train. (41)

We ae responding to these situations by: 1) recognizing that they exist; 2) maintaining "internal" meetings and awareness on this subject. (42)

Short term reaction to specific problems. (43)

- (44)

We financially support community development and encourage our employees to participate in community activities. We also provide scientific expertise to enhance local science education. (45)

No major programs have been initiated - we do answer routinely written (sometimes oral) questions and criticisms of our operations. (46)

We have several programs with universities, schools, local governments and special interest groups to present a more balanced picture of our industry. (47)

We have focussed on solving enviornmental problems through a new subsidiary dedicated fully to this endeavor. As an owner/operator of facilities we have faced the difficult regulatory climate and have addressed the concerns of the public and the regulatory bodies in seeking approval for projects. (48)

We have played a leading role in the areas of recycling, nutrition, education, food safety and public health safety both as a private organization and in conjunction with the trade associations and regulatory agencies with which we are affiliated. (49)

We are strengthening our public relations stance, promoting greater interaction with, and support of, academia. (50)

Yes, some but not really much. (51)

## VI. INTERNATIONAL PERSPECTIVE

### A. WITH REFERENCE TO THE INTERNATIONAL SCIENTIFIC COMMUNITY, DO YOU ENVISION ENHANCED LEVELS OF COMMUNICATION AND COOPERATION WITH SCIENTISTS ABROAD? IF SO, IN WHAT MANNER?

Yes, probably through TV's in Japan and Germany and South America (1)

See III (C). (2)

Definitely yes. More attendance at international technical meetings. More visits to foreign subsidiaries and universities. We encourage thinking on a world, rather than a national, basis. (3)

Yes, cross licensing of technology (4)

Probably more international meetings. (5)

Yes but I am not close enough to the international technical community to say in what manner. (6)

This exists already since many of our employees are from abroad. I don't anticipate much change for us. (7)

No. (8)

Yes we already do. (9)

Yes, by encouraging interaction of our scientists through international technical associations (10)

Although many international contacts in chemistry are in place, new contacts will be needed in life sciences, and electronics. Cooperative industry/academic research is used to make specific contacts. More widespread contact will come through organizations like our R&D unit recently started in Japan. (11)

No. (12)

We expect more cooperation because business is becoming more international. (13)

Not really. (14)

Yes. (15)

Communication - yes. (16)

Yes - We already have in place a mechanism for interacting with European and Japanese scientists. This is our New Technology function

which operates from our Research Center in Wilmington. Two years ago we expanded this function to include our personnel located in Europe and Japan (a technical leader) to interact with companies and universities on a more regular basis than we can from the U.S. Also, we have expanded our "Grants in Aid" to include foreign universities as well as U.S. universities. For years we have participated in international meetings and will continue to do so. (17)

Yes our industry has always been quite international in scope (pulp & paper) (18)

Yes. More cooperative programs with overseas institutions. (19)

Yes. International meetings will probably be electronic as well as in person. Exchange of personnel from lab to lab might be possible in industry as well as academia. (20)

Yes. Scientific meetings and programs, mergers and joint ventures; cross-licensing arrangements. (21)

Yes. Increased funds have allowed many scientists from abroad and the U.S. to attend meetings around the globe. The high cost of development almost dictates worldwide marketing. Cooperation between foreign subsidiaries has greatly increased since a two-tiered system is too expensive. (22)

Absolutely. In our field the leading scientists are in Japan and Europe. (23)

Communication and scientific data retrieval is constantly improving. With this will come more communication and more cooperation. (24)

No. (25)

Yes, especially since we are now Hoechst-Celanese. But we have been operating with international scientsts from many years in university, joint R&D, and symposia. (26)

No. (27)

I hope so. However, I think it will be more through government initiatives. Multinational companies could help enormously if they could be convinced it was in their interest to do so. (28)

Academically-yes; corporately-no. Publication of academic research. (29)

In a broad manner-yes. In the oil business, probably not. (30)

No. (31)

Needed. (32)

Not envisioned in our areas. (33)

We have some communication and co-operation with Scientists abroad through licensing. (34)

Yes. We will bne actively seeking joint ventures and R&D partnerships on an international basis. We are all now addressing world markets. (35)

Forsee no significant change. (36)

No. (37)

Yes, as costs escalate, imcreased levels of cooperation intellectually and economically become a necessity to achieve the goals of science. This will come about through governmental cooperative efforts, industrial investment, etc. (38)

Definitely an increased communication through meetings and journals of Japanese, European and American scientist. Also, postdocs and sabbaticals are more international. The cutting edge of most scientific areas is becoming truly one worldwide criterion. (39)

- (40)

N/A. (41)

I envision increased cooperation with the overseas community. Internationally, the science is first-rate; marketing needs are being identified continually; in short, because of the opportunities, cooperation will increase. (42)

Improved international communication within international companies. (43)

Yes, more travel to foreign meetings is now being supported. (44)

Yes. The driving forces for increasing international communication and cooperation are: (1) the European countries and the Pacific region have become major players in the advancement of science, (2) technical products now often compete on a worldwide basis, (3) escalating R&D costs demand fast global commercialization of developed products. (45)

Do not anticipate any significant increases in international activities (46)

No. (47)

In the international arena, we have, since the post World War II period began, built large self supporting affiliates staffed by nationals. Most of the dealings with scientists abroad are through our affiliated companies to satisfy the needs of their own business opportunities. (48)

Yes, since we are internationally involved we strive to work closely with the scientists from both our supplier organizations and our good

customers. This also enables us to have contact with scientists in international academia. When such people visit us in the states, we encourage them to participate in seminars at our laboratories here. (49)

Already at a strong level and will continue to grow. (50)

Absolutely. We are becoming one world, all speaking English! (51)

B. AS YOUR COMPANY DEVELOPS MARKETING STRATEGIES, IS THERE A GREATER ATTENTION GIVEN TO MEETING CHALLENGES FROM FOREIGN CORPORATIONS IN RESPONSE TO A NEW LEVEL OF INTERNATIONAL COMPETITION? IF SO, HOW?

Yes - via TV's and new plants in Europe, R&D is directing its attention more to specific products needed outside the U.S. (1)

Yes. We aim at "world" products as opposed to products for individual countries. With relatively low unit value products we're less susceptible to import threats than, e.g., autos, cameras, TV's etc. (3)

We think globally. (4)

Yes, where it is a factor. (5)

No. (6)

Not much, because of the nature of our company. Our challenges come from domestic companies almost exclusively. (7)

No. (8)

We belong to a foreign corporation. (9)

Yes as foreign corporations adapt our technology our advantage will more and more reside in our ability to innovate. (10)

Most certainly. To the extent possible in various countries, a significant investment and direct participation in both marketplace and other business activities (manufacture; R&D) in each country is being explored. Recent examples for our company include joint manufacturing agreements, direct market participation, and R&D facilities in Japan. (11)

No. (12)

Very much so by being leaner, more focused, and trying to do our business right. (13)

A competitor is a competitor. (14)

No. (15)

Can't speak for marketing. (16)

We are more keenly aware of our role in a worldwide market, but I can't say we give greater attention to foreign competition. We just no longer overlook this competitive force. (17)

Not too pressing for us, except when the $ is strong. (18)

Yes. Faster movement form R&D into the marketplace. Eat more sushi to discover secret of competitor's strengths. (19)

No more that to meeting domestic competition. (20)

I don't know. (21)

Yes. This industry has always competed on a worldwide basis. With the increased sophistication of foreign competitors, the advantage of the American science has shrunk. We have to be very selective and prudent with our research funds, given the foreign competition still has cheaper labor available. (22)

We have eleven competitors worldwide only one in U.S. We generally try to beat them in every area except their home country. The U.S. market is declining as a percent of the whole market. (23)

While our firm has always had international sales, we are just now attempting to set up organized marketing plans for distinct overseas markets - common market/Japan/China/India, etc. (24)

More attention paid to global planning. (25)

Yes, always factor in the global perspective since we are a multinational company. (26)

We work with a congressional liaison to change tariff regulations. We work with FTC to prevent dumping. (27)

Yes, in our business competition is fierce and a way of life. (28)

Not on a direct product basis, but more on specialized applications through our customers. Competition most severely felt by our customers being purchased by foreign multinationals. (29)

No. (30)

Yes - surviving price cutting from foreign companies. (31)

Decidedly, the majority of our markets have shifted from local to global in the last decade. Wide currency swings have had much to do with this. (32)

Foreign competition is a major concern. (33)

Foreign competition is not considered new. We pay attention to our best computers which generally are Japanese. (34)

Our competitor analysis of existing and new product lines clearly includes foreign corporations. Perhaps the only thing that has really changed is the degree of consideration now given to worldwide competitors. (35)

Varies from product sector to product sector. (36)

Global yes, our markets are. (37)

This is not really a problem at this time in our domestic market. However, in the international market we must deal with many government monopolies which require unique business strategies involving actions by the Company and the federal government. (38)

Yes. Many Japanese and European companies are now introducing new products directly into the U.S. market rather than through U.S. partners. the products with the best profile of properties and advantages are increasingly taking a greater market share, regardless of which company first launches the product. Our company looks at early launches in European and Eastern markets, not just the U.S. (39)

- (40)

N/A (41)

Foreign companies are formidable competitors. Our forward plans include assessment of their role in U.S./foreign markets; and include the impact of their acquisition policies on our businesses. (42)

No knowledge. (43)

Has been this way since 1980. Japan is our major competitor. (44)

Yes. Not only are we preparing to meet challenges from foreign corporations, we are also coordinating our product developments and marketing strategies to address overseas markets. We hold worldwide meetings, in which our marketing and technical staffs around the world participate, for each of our major product lines. (45)

Foreign competition has always been a factor to be considered. (46)

I wouldn't say more, but they are certainly requiring more of our focus as we review competition, because they have become a larger competitor. The only key challenge that we have is gathering a thorough understanding of their goals and strategies which requires a much more extensive market research effort. (47)

Since our traditional business activities are concerned with world-wide activities, we are accustomed to meeting challenges from foreign corporations. Therefore there is no greater or lesser attention given to this area. Some of our newer areas of activity are inherently domestic, and are not (at present) subject to foreign competition. (48)

There is not a greater attention since we have been on the international scene for a number of years. Our international network helps keep us abreast of worldwide trends in packaging and, thus, aids in our long-range planning to stay at the technical and marketing forefront. (49)

We are concerned about the foreign threat and competition. We are responding by closer monitoring of foreign developments and opportunities. (50)

Absolutely. Again, we plan (and have for three decades) on a world basis. (51)

C. IF YOUR COMPANY IS A MULTINATIONAL, HAVE YOU EXPERIENCED ANY IMPORTANT REDISTRIBUTION OF RESOURCES, OR SHIFTS IN EMPHASIS IN THE PROPORTION OF DOMESTIC VERSUS FOREIGN OPERATIONS (E.G. MANPOWER, RESEARCH, PHYSICAL PLANTS OR CAPITAL)?

Not in R&D yet - but we have in other functional areas. (1)

No. (2)

We have heavy investment in manpower, R&D, and plants in foreign countries. This trend is increasing. We presently operate in over 25 countries around the world. (3)

No. (4)

No. (5)

No. (6)

No. Nothing significant. (7)

Production and engineering support for our traditional manufacturing technology continues to move off shore. (8)

No. Domestic operations will probably grow. (9)

No major changes. (10)

There is more awareness of a "world manufacturing" environment today as compared to ten years ago. For mature technologies any further redistribution will be influenced by cost factors. For emerging lines of business, investment will be based on technology and market locations. Good communication between research and development will help decide research investment locations. (11)

No. (12)

Yes, there has been a shift abroad in all these categories, save research. Such shifts are determined by labor costs, currency ratios, business costs and considerations that are not related to chemical issues as such. (13)

N/A (14)

No. (15)

Sure - based on economic reality. (16)

Over the past decade essentially no new grass roots plants have been built in the U.S. except those related to U.S. Aeorspace by our company. All

other new plants have been built overseas. This is to utilize cheaper foreign production costs and protect us against swings in the dollar value. Up to this point there has been little increase in the percentage of our research carried out overseas. (17)

Not applicable. (18)

Little. Some increased emphasis on foreign operations but still most effort is domestic (19)

Not in the past 10 years. (20)

No shifts at this time. (21)

Yes. We are trying to please the less sophisticated tastes in the foreign countries with cheaper labor. In some instances, favorable tax treatment is also a factor (Puerto Rico as an example). (22)

Our growth in Non-US areas is significantly greater than here. As a result, our growth in capital spending, manufacturing and research is growing outside U.S. (23)

N/A (24)

We are multinational. No important redistribution. (25)

Some plants overseas have been built or expanded at the expense of U.S. Not in R&D. (26)

We are multinational - little change. (27)

Nothing drastic. (28)

Yes, to foreign sites for capital investment, research, etc. (29)

No. (30)

- (31)

Nominally we are a multinational, but effectively, no. (32)

Not multi-national. (33)

Some shift is noticeable. Company has set up several manufacturing facilities outside the U.S.A. in last few years. (34)

Nothing of significance in R&D--yet. (35)

No major shifts. (36)

No. (37)

No. (38)

We have increased development resources, not basic research resources in non-U.S. locations, in order to improve our ability to register new products in non-U.S. territories. Although U.S. science is regarded as good and even sufficient, local studies are often mandatory for favorable pricing by local governments. (39)

- (40)

N/A (41)

In R&D, we find that overseas R&D facilities may be important to the business as a whole because of their technical understanding of overseas markets. (42)

No, tends to change with the value of the dollar. (43)

No. (44)

There is a shift in emphasis toward foreign operations, especially in the R&D area. (45)

- (46)

No. (47)

In recent years, our overseas operations in the engineering and construction sector have enjoyed a healthier business climate than our U.S. arm. There has been attrition in manpower more in the U.S. operations than in the European operations. (48)

The distribution of resources has been based on opportunities for growth on the multinational scene as well as the shift in packaging materials and types of packaging. Certainly the plastics area has seen greater emphasis in recent years. (49)

No major redistribution. All our major international operations have grown proportionally. (50)

Of course, a shift towards foreign. (51)

D. FINANCIAL AND BUSINESS PUBLICATIONS HAVE NOTED THAT UP TO ONE-THIRD OF U.S. CHEMICAL SALES DOLLARS ARE CONTROLLED BY OVERSEAS CONCERNS (BUS. WK. 1/12/87). DO YOU CONSIDER THIS TRUE, AND IF SO, HOW WILL THIS AFFECT THE U.S. CHEMICAL INDUSTRY?

It's probably true & more recently a result of the weakened dollar (e.g., Hoechst/Celanese). I'm not yet sure of the effect, but hope this does not result in weakening U.S. Chemical Industry. (1)

Presently, we can observe the transfer of new technologies to foreign countries. (2)

Don't know if this is true. If true, the overseas competition will be good for US industry. (3)

Don't know. (5)

We are not in the basic chemical industry & I can't comment. (6)

This may be true. I have no comment of possible effect. (7)

Yes, this is an excellent base from which we can continue our global marketing efforts. (8)

? (10)

If we "assume" the Business Week report is true, what should the U.S. Chemical industry be thinking? It seems reasonable that mature technology areas may be most affected by overseas competition pressure. U.S. chemical industry will need to identify such areas to either make them move cost effective or shift toward more high-value materials/ technology. (11)

No comment (12)

We are not a chemical company, but we do not have information contradicting Business Week. (13)

1) Insufficient data. 2) Insufficient data - depending upon the industry and the company involved it may have either a beneficial or negative effect. (14)

We have become a global industry - it is already in effect. (15)

Probably true. If the control increases, it may well be just another contribution to a truly international scientific community - good or bad. (16)

Yes — When the dollar is strong, they can sell chemicals produced overseas in the U.S. market. When the dollar is weak, they can produce in their U.S. plants. (17)

Not applicable (18)

In what sense "control"? (19)

I don't know. (20)

I don't know. (21)

The declining dollar has allowed many foreign investors to move much more rapidly into this country. Obviously a loss of revenue to U.S. corporation will not improve the balance of payments and is detrimental to the industry. (22)

I will accept it as true. The chemical industry, if defined as that which produces the 50 top chemical products, will likely go out of existance in twenty years. Many companies will remain doing new things not generally regarded as chemicals. (23)

Probably true. I am not capable to comment on the effects, if any, this may have. (24)

Probably true. Foreign concerns are establishing increasing presence in U.S. and this is having an adverse effect on U.S. industry. (25)

No comment. (26)

True and something which bothers us. (27)

The entire trade question - unbalance, etc. definitely threatens the U.S. standard of living, the existance of a strong middle class, and eventually democracy itself. For the good of the U.S. and the entire world a more sane and logical policy must be established. (28)

Yes, very adversely. (29)

Don't know. (30)

Unknown. (31)

Yes. The monolithic American market is irresistible to others. Our challenge is to learn to sell in non-mass markets. (32)

We have experienced this in several of our product areas-know that it is true for our product areas. Will weaken our industry. Many intermediates are all off-shore. (33)

No comment. (34)

I'm not convinced of the statistic. What is the impact of multi-nationals on this? If it were true, one of the most notable effects might be to catalyze the introduction of new technology. (35)

No opinion. (36)

- (37)

Yes. It will cause them to increase their level of productivity and invest capital to upgrade their facilities. (38)

It may actually increase beyond one-third because of import-export laws and taxes, lower wages in Eastern and Latin territories, government sponsored industry (Puerto Rico, Ireland, Taiwan, So. Korea), and monetary exchange rates decreasing the value of a dollar. Chemical commodities will become less competitive for the U.S., specialty chemicals will become important and profitable. (39)

- (40)

- (41)

Cannot answer this question. (42)

Yes, in the short run this will be bad, but in the long run we will hopefully be more competitive. (43)

- (44)

This is probably true and is an inevitable result of international competition. At a time when foreign concerns are taking a foothold in U.S. markets, it is becoming even more important for the U.S. chemical industry to expand aggressively in the overseas markets. (45)

- (46)

I have no reason to doubt this figure. It does nothing to us except to remind us we must make decisions recognizing worldwide factors not just U.S. factors. (47)

Since we are not in the business of chemical production and sales, we are not qualified to answer this question with authority. However, as a long-term international company, we are comfortable with overseas concerns. If the statement is true, we expect the U.S. chemical industry will function as before, with its success dependent on market competitiveness more than on who controls the industry. (48)

I do not have the facts to address this issue. (49)

- (50)

? (51)

VII. ACS IMAGE

A. WHAT IS THE ATTITUDE OF CORPORATE MANAGEMENT EITHER IN YOUR COMPANY AND/OR IN THE INDUSTRY AS A WHOLE TOWARDS THE AMERICAN CHEMICAL SOCIETY (E.G. SUPPORTIVE, AWARE, INDIFFERENT, WARY)? PLEASE ELABORATE.

I suspect indifference. There are many (individuals) in company management spots who feel that ACS is too "academic." Of course I disagree, and expect that management will change its mind with real data. (1)

Aware. Our company's major focus is not toward the chemical sciences. However, the numerous chemistry organizations within the corporate structure are highly supportive of the ACS. (2)

Supportive in that we're Corporation Associates members. We also support financially the local ACS section, have utilized ACS Short Courses, TV hook-ups, and have members of our R&D staff on national ACS committees. We also have fellowships with 4 ACS technical societies. (3)

Aware but not too involved. (4)

Aware and supportive. (5)

Indifferent. (6)

Our management is somewhere between aware & indifferent when taken as a whole. Only a very few could be considered supportive. On the other hand, I would not classify any as wary. (7)

Supportive, ACS has an excellent reputation both inside and outside the industrial society for its interests in chemistry. (8)

We and many of our staff are members of ACS. (9)

Indifferent. Chemists are a technical minority. (10)

Generally aware for the company management as a whole. Managers with chemical or chemical engineering background are among the top ranks of management in our company. They perceive ACS as a top-ranked professional Society, JACS as a premier journal, and Chemical Abstracts as an excellent resource. Some of our research managers strongly encourage the ACS to be more forward looking and expansive, embracing new disciplines in which chemistry is important (materials science, life sciences, molecular biology, electronic materials, ceramics,...). A continuous examination of national meetings, regional meetings, communication methods, etc. was also suggested. (11)

Supportive. Seen as a professional society. Role is dealing with technical not social or business issues. (12)

As a rule, the company management is supportive of technical and scientific societies, ACS included. (13)

Aware, supportive. (14)

Boring. (15)

In general (but with noteworthy exceptions) chemists are absent from management. Why then would management comprised of marketing and financial people be other than indifferent to the ACS? (16)

Corporate management very supportive of ACS; e.g., a) long time member of Corporation Associates, b) provides time and support services for ACS members to participate in local and national ACS activities, c) encourages presentations at regional and national ACS meetings, and d) contributes to pre-1965 registration of chemical programs. (17)

Mildly supportive. Strongly support pulp and paper associations. (18)

Supportive and aware. Basically feels that ACS does a good job. (19)

The very fact that we are Corporation Associates shows a commitment to ACS. I would judge that chemical management is supportive, corporate management less so. (20)

My company is very supportive of the ACS. (21)

For the most part, ACS is just another organization which there are many in our industry. Generally, this corporation supports the ACS, pays dues to CA and pays the employees dues. Participation in ACS sponsored activities is allowed if not encouraged. I think this corporation looks at the ACS just as another expense which is essential to do business. (22)

Supportive in the sense that it is needed for professionalism and Chemical Abstracts Services. Generally, the ACS is considered to be too bureaucractic and lacks innovative action. (23)

Being management, you will have to take my word for it. Our little company has always supported the ACS and used it to the some extent to promote our image. We support membership in Carb./Small Business Div./Corp. Assoc. I think the ACS is doing a fine job of presenting the industry position. I think you could do more. (24)

Company attitude toward ACS is in vicinity of aware to indifferent. (25)

Usually supportive but they are less aware of ACS than of large trade associations such as CMA, Conference Board, SOCMA. (26)

Indifferent but aware. (27)

Corporate management has a benign attitude toward the ACS - a few of us are aware, and supportive - most are fairly indifferent. (28)

Supportive but not very active at our location. (29)

The company is largely supportive in that it allows company facilities to be used for meetings, and ACS members to attend national or regional meetings at company expense. Top executive management, however, probably does not know about ACS policies and is indifferent to them. (30)

Too academic oriented. (31)

Indifferent to wary. What benefit? (32)

The organization is aware of the ACS. Encourages interaction. (33)

Supportive but indifferent. Not sure that managers and non-members understand clearly ACS's role. (34)

Generally aware, mildly supportive. (35)

Aware/supportive. (36)

Essentially an invisible entity. (37)

In general, I think corporate management as a whole is aware of the ACS but as management they are indifferent as it has no impact on business operations. As individual scientists, they are active locally, nationally, and internationally. (38)

Supportive but not critical or pivotal. Organizations like the PMA derive more management support because they have a role for marketing, legal and regulatory people as well as scientists; their concerns are for the entire industry. The ACS is considered a successful scientific organization because of its meetings, but otherwise it is viewed largely as a special interest group. (39)

I believe industry as a whole views the ACS as an employee organization and is therefore passively supportive. In general I believe industry finds it difficult to identify "corporate gains" for the ACS. I personally believe the ACS should be an organization dedicated to the individual scientist. (40)

Aware. (41)

In general, the chemical industry as a whole is indifferent to the ACS. ACS is not "active", i.e. no inter-industry position on issues; no cooperative studies, etc. (42)

Weakly supportive. (43)

Our research management actively supports our participation in ACS activities, divisions, etc. (44)

We are supportive of the ACS and appreciate the fine service that the society has provided to the chemical industry. Many of our employees

are ACS members and we encourage their participation in ACS meetings, and publication in various ACS journals. We also sponsor and provide facilities for local ACS meetings. (45)

Corporate management is supportive of the American Chemical Society. We have been active in Corporation Associates and in local section activities and encourage attendance at local and national meetings. (46)

It is supportive. (47)

Because of the diverse nature of our company, service to the chemical industry is only a part of our business activity. At the corporate management level, there is probably a feeling of indifference to the ACS as other problems absorb management's attention. This is even more prevalent as our traditional business areas remain depressed. (48)

As a whole, corporate management is unaware of the ACS. ACS does not have as public a face with respect to the numerous technical and social issues which face our industries and our society as do other organizations of which they indeed are aware. This makes it more difficult as we try to justify our membership in ACS in the face of stringent budgets. I believe ACS needs to assess in its future planning what type of effective role it can play in issues management for the industries which support the ACS. (49)

We are very supportive of the ACS, and would like to see a continued active participation of the ACS in public/government education regarding the chemical and pharmaceutical industry. (50)

Yes, supportive and aware. Generally fine! (51)

## KEY REFERENCES FOR FURTHER READING

The following articles further describe recent and projected chemical industry trends.


1. "The Chemical Industry: Where in the World is It Going?", Papers presented at the September, 1986, meeting of the World Chemical Congress of Marketing and Business Research in Newport Beach, CA. The program was cosponsored by the American Chemical Society Division of Chemical Marketing and Economics, and the Chemical Marketing Research Association. (Symposia book available from the Chemical Marketing Research Association.)

2. Bennett, Michael J.; Boccone, Andrew A.; Kline, Charles H., "Managing the New Chemical Company", C.H. Kline & Company.

3. Bower, Joseph L., When Markets Quake: The Management Challenge of Restructuring Industry, Harvard Business School, 11/1986, 240p. Distributed by Harper & Row Publishers, Inc.

4. Kline, Charles H., "Reshaping the Chemical Industries." CHEMTECH, Vol. 16, No. 8, Pages 478-483, August 1986 and No. 9, page 515, September 1986.

5. Kridl, Andrew G., "The Chemical Industry: Lessons for a Change. A Giant Industry in Flux." Report #745, Winter 1986-1987, Business Intelligence Program SIR International. (Available from SRI International for their members only.)

6. Loos, Karl D., "Chemical Industry Growth After Restructuring." A report from Arthur D. Little, Inc.